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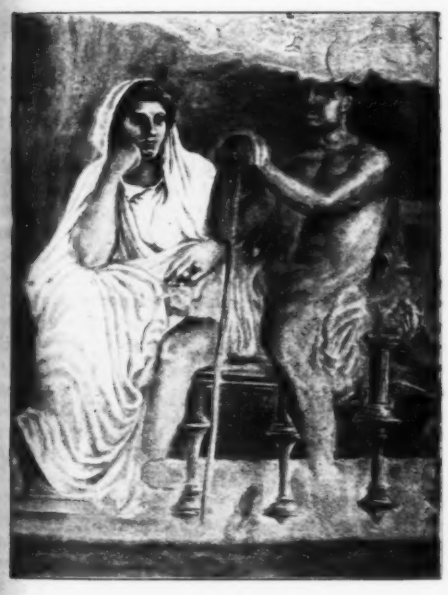
THE BOSCOREALE RELICS.

One of the most interesting discoveries made at Pompeii within recent years was that of the Roman villa Boscoreale, with its frescoes and mosaics. The excavation of the villa also brought to light a collection of silverware of different forms and high artistic value. The greater part of this collection was acquired by the Baron de Rothschild and presented by him to the Louvre. Boscoreale is about two miles north of Pompeii and to the southeast of Vesuvius, occupying a somewhat elevated site. Barnabei and Sogliano have searched with rare patience all the documents which might throw some light upon the history of this house. Tablets show that it was sold at auction on the ninth of May, in the twelfth year of the Christian era, under the first consulate of Germanicus. Another tablet found in the *villa rustica* bearing the name of P. Tannius Synistor led one to think that the last owner was thus named. But a bronze seal found later suggested another name, that of Lucius Herennius Florus, who was probably the last owner of the house.

In digging the foundations of a wall the existence of ancient constructions was made evident as early as 1876, but it was not until 1896 that the present excavations were carried out by M. Vincenzo de Prisco. It was found that the constructions formed a rectangle measuring 130 feet long by 80 wide, and proved to be a villa or farm house, containing two main parts, one consisting of the dwelling house proper and the other of the various buildings for the production of wine.

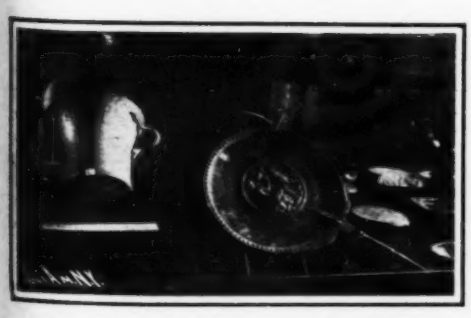
The walls of the dwelling house were built of cut lava alternating with layers of brick, while for the other buildings the spongy sarno and ancient materials were used, among which were found debris of cut marble. The floors of the rooms are in mosaic. The finest has a dragon for the principal subject. The villa and outbuildings are surrounded by a wall; great earthen vases, used for storing the wheat, may be seen. Those which are still intact are found planted upright in the ground. A large circular metal basin, upon a stone support, is also to be remarked. In the inclosure of the villa were found a great number of utensils, and at the left of the entry, near the porter's lodge, a dog was found dead at his post; his stretched chain shows the efforts he made to escape the peril. The collection of silverware which forms the most important of the objects was found in the wine reservoir, and it seems to be clearly indicated that the pieces were carried to this hiding place at the time of the eruption; nearby was found the body of the man supposed to



PANEL FROM THE TRICLINIUM.

PANEL FROM THE TRICLINIUM.

THE ZITHERIST PANEL FROM THE TRICLINIUM.



A MIRROR AND CUP IN THE BOSCOREALE COLLECTION.

A SILVER CUP AND A SALT CELLAR AMONG THE BOSCOREALE COLLECTION.

PART OF THE BOSCOREALE SILVER IN THE LOUVRE.

THE BOSCOREALE RELICS.

have carried them; he had fallen upon his hands and knees with his face to the ground. At his sides were found four gold bracelets, besides earrings, a chain and about a thousand pieces of gold coin, whose effigies form a complete series from Augustus to Domitian; the latest piece is of the year 76. The gold has not been appreciably altered, but the silver pieces were blackened and some of them were covered with a sulphurous deposit; the handles and feet of most of the vases had become detached.

The collection was put on sale and the price of $100,000 was asked. The French government offered only $50,000, but the Baron de Rothschild bought for $80,000 ninety-five pieces of silverware, which he presented to the Louvre; other gifts have increased the total number of pieces at the museum to 102. Two of the finest of these pieces are shown in the engravings. The first is a patera formed of two parts, a central medallion in high relief and an outer rim with an engraved border of leaf design. The medallion represents the city of Alexandria, which is personified by a woman shown in bust with the head strongly projecting. A head-dress of strange character represents an elephant, whose trunk and tusks curve upward in front, while the ears fall down at the sides of the head. The ears of the woman are pierced with small holes, from which were no doubt suspended earrings of gold which have not been found. The figure holds in the right hand the *uræus*, or sacred serpent, emblem of the divinity and of the royal dignity of Egypt. In the center are different emblems, such as fruit, a peacock, an ear of wheat, and to the left is a female panther facing the serpent. The left hand holds a cornucopia ornamented with a relief design and containing grapes and pomegranates surmounted by a crescent. A lion in relief rests upon the right shoulder, as guardian of the city. The central medallion was gilded, with the exception of the flesh parts, and traces of the gilding still remain. The repoussé work of this piece is of an extraordinary character and its preservation is perfect. The medallion has a diameter of 6 inches, and the whole piece 9 inches; it weighs about 24 ounces. Two important pieces are a pair of wine vases, one of which is shown in the engraving. It is ornamented with a subject representing the Victories sacrificing before the altar of Minerva. The neck of the vase has an infant, or genius, terminating in leaf design offering a cup to a griffin; this design is repeated on the other side of the neck. A border separates it from the lower part; a statue of Minerva, with drapery and casque, occupies the middle of the design (seen in profile to the right), standing upon an altar decorated with emblems. The right hand carries a round shield and the left a spear. One of the Victories is shown in the act of sacrificing a deer, and that of the opposite side is seated upon a ram and holds a laurel branch. The vases, excepting the flesh parts, were also gilded. Their height is about 10 inches and weight 22 ounces. The collection contains a great number of interesting pieces, many of which have a high artistic value, including bowls, pitchers, drinking vases, and cups, besides two mirrors with fine ornamentation. Among the small pieces are round salt cellars with feet, spoons, and wine strainers.

The villa is ornamented with handsome frescoes, which have been acquired by the Metropolitan Museum of Art in New York city. The frescoes were unearthed in 1901.

By a refinement of luxury due to the conquests of the Romans in Asia, the paintings which ornamented the walls of this sumptuous villa represented the best examples of the art of that time. We do not know the name of the patrician who built this house of allurement, but the paintings found there readily suggest that he was a lover of music and also of games such as wrestling. Many of the paintings represent musicians and athletes and upon one fresco can be seen a table loaded with prizes for the games, among them being crowns of gold.

The paintings belong to two different epochs. The most ancient (severe architecture, imitation of precious marbles and large figured panels) date probably from the first years of our era; others more *rococo* in treatment are certainly of later date than the sale of the house in the twelfth year of the Christian era.

It is not necessary to recall the rôle of the Pompeiian pictures. The archæologist and the historian find in them the best elements for the reconstruction of furniture and products of industrial art, the explanation of the religion and customs of the Roman people, the illustration by image of the literary works of the last century before Christ and the first of our era. The paintings of the villa of Lucius Herennius Florus are among the most interesting with all these points of view in mind. The instruction which one derives from them and the admiration which they arouse are considerable. On an artistic side, too, their worth is immeasurable. These paintings are the reflection of Alexandrine art—an art both spiritual and sentimental. Up to this time Alexandrine art has not been the object of especial study. It is not necessary to examine closely into the number of mediocre examples which belong to the long and fatiguing decadence of this art under the Roman Empire, but one should surely examine the creative force of the artists of the glorious Ptolemaic epoch, the third century before Christ, during the literary spring and florescence of that exquisite pastoral poetry whose echo we find in more than one of the Boscoreale paintings.

The frescoes obtained from the villa Pisanella are largely from the *cubiculum* (bed-chamber), *triclinium* (banquet hall), and *tablinum* (room containing family records and hereditary statues). The latter are far more important and represent in a peculiarly good condition the best examples of ancient art.

The "Zitherist" is the most noteworthy of the panels, and is from the *triclinium*. It represents a young woman of the classic style of beauty and is considered by some the most beautiful portrait in colors which antiquity has left us. The artist has sought to express the soul of his model and has left in the work the imprint of his emotion. She is seated upon a chair, painted and carved, and with a high and straight back (*la cathedra*). Her garment, the *stola*, is the long flowing robe so loved by the ancient Romans. She holds a gilded zither, while behind the chair stands a little girl. The red background brings out the blue gown and white mantle to perfection.

Next in importance comes the picture of two seated figures. A man, undoubtedly an athlete, is seated upon a long chair and seems proud of his manly and energetic beauty. His hands rest upon a staff. Beside him is seated a woman, her head enveloped in a mantle. She fixes her eyes upon her companion, but with the vague regard of a dreamer. The artist probably grouped them with the intention of representing a legendary subject whose meaning it is difficult to comprehend.

The woman holding a shield, while less artistic, is nevertheless interesting. She stands almost full-faced the head turned a little to the left, while her gaze is turned upward. She holds, partly resting on her knee, a shield. Her robe is white with a blue mantle.

The *tablinum* was almost square in form. The walls were ornamented with plates imitating marbles of different colors. Upon these walls were painted heads of young bulls adorned for the sacrifice, masques, and garlands of fruits and greens. Four panels, well preserved, have been taken from it.

The third wall of the alcove of the *cubiculum* offers a decoration full of charm. The eye reposes with pleasure upon a garden in which there is an artificial grotto known as *musaea*. Creepers of ivy cling to the rocks carpeted with moss. Birds of gay plumage dart from rock to rock. Above the grotto is a large passage (*gestatio*) bordered with a balustrade. To the left is an open window with bars.

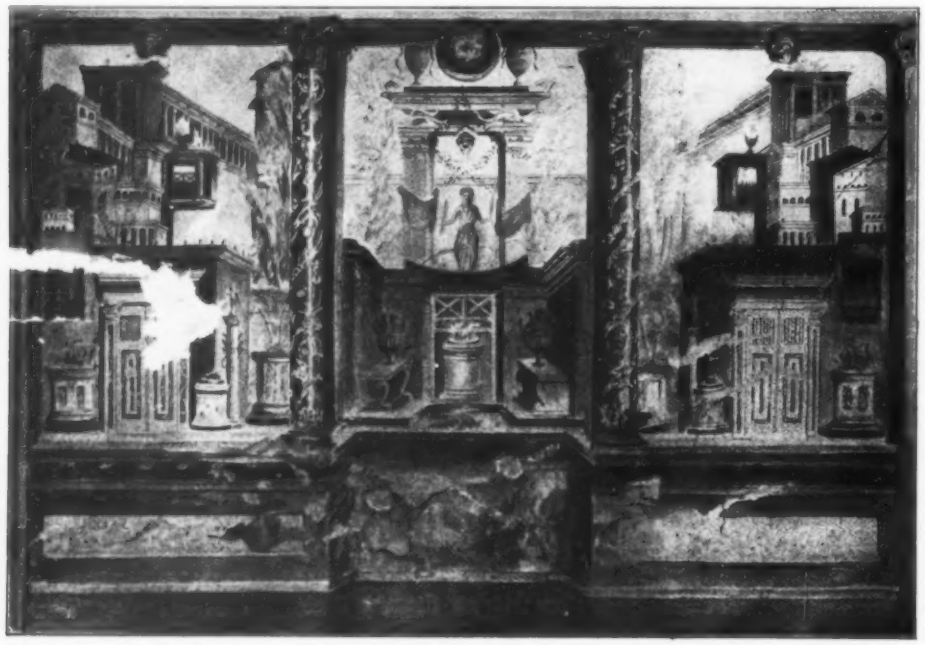
Another panel from the *cubiculum* represents a row of Corinthian columns resting upon a wainscot. These columns support a *cymatium* decorated with masques of satyrs. In the first section arises a temple with an altar and a column surmounted by a winged goddess (Artemis) holding two flambeaux. In the distance are houses, terraces, porticoes, balconies, and hanging gardens. In the second section a marble support holds a gold *hydra*. In the center is an altar, below which is an offering of fruits. Behind rises an edicule decorated with greens, a masque of Silenus and draperies. It supports on the cornice a shield and two gold vases. The statue is of Hecate or Diana, who is the guardian of the house. The third section is a reverse presentation of the first. Another panel from the *cubiculum* represents a sacred inclosure encircled by a portico of a double row of Corinthian columns. In the center a circular monopteral temple of twelve columns arises. The principal entrance to the portico faces the spectator. In front of this entrance is an altar loaded with offerings.

In all these paintings there is a woful lack of perspective, and the drawing is careless. But the color sense of the artists who painted them was keen, and the fine Pompeian reds still hold their wonderful tone.

The great panels of the figures of the zitherist and of the athlete belong to great art. They are living portraits, the most beautiful that antiquity has transmitted. The panels from the *peristyle*, the *tablinum*, and the *triclinium* are in a noble and severe style which commands admiration. The panels from the *cubiculum* are among the most interesting of the decorative paintings of Pompeii. One thing is remarkable in these paintings—the law of perspective is a *melange* of realism and fantasy.

Although the relatively low artistic worth of these paintings may detract somewhat from our enjoyment of them, still as evidence of the skill of the Pompeians, in an age when art had not reached the heights it did later, they are exceedingly valuable.

These Pompeian paintings seem like dreams—dreams of riches and of pleasure. In them we recognize the very soul of the epoch which they represent and the refined voluptuousness of the Romans of the great empire. They are the best translation of a Horatian ode.



PANEL FROM THE CUBICULUM.

THE BOSCOREALE RELICS.

NILSSON'S AND BURBANK'S METHODS IN PLANT BREEDING.*

By PROF. HERBERT MAULE RICHARDS.

PLANTS are now bred systematically for desired characters, not always simply for increased yield, but also for such qualities as resistance to extremes of temperature, to lack of moisture in dry or semi-arid regions, to resistance toward specific diseases, and even for the more esthetic qualities of flavor or color. The old hit-or-miss methods of the improvement of strains by empirical rules of selection is passing away, and more and more scientific methods, based on the latest results of investigations of heredity and variation, are being employed. Passing over the older methods I will take up two very different types of plant breeding, both modern: one the strictly scientific, the other the intuitive.

The first method we owe largely to Nilsson, who introduced it at an experiment station in Sweden in connection with the cultivation of various cereal crops. It may be said that previous to his advent the older methods had been tried and abandoned as a failure. With his knowledge of what had been published about heredity and variation, Nilsson, after some preliminary experiments, arrived at the conclusion that no new, pure or constant strains of wheat could be obtained unless the fruit of a single ear was bred separately, and thus he established what is known as the principle of breeding from the single ear and not from assorted lots of seed taken from many individuals. This breeding he continued, picking out any chance

* Abstracted from a lecture on "Botany," delivered at Columbia University in the series on Science, Philosophy and Art.

favorable ear which he could find, until he obtained many thousands of different forms owing to this multiplicity of strains mixed in the ordinary wheat. Of course some turned out to be mere bastard strains and only the ones which continued to breed true to character were kept. These constituted the new agricultural varieties—in reality elementary species and mutants—which, after severe tests had proved them suitable, were raised in marketable quantity for seed. The amount of work involved was enormous; the mere bookkeeping of the accurate pedigree record with notes on the life history of each form and its progeny was in itself no small matter. Besides the principle of single-ear breeding, Nilsson also established the fact that but a single selection alone is necessary to fix a new strain, provided the progeny of the chosen ear are carefully guarded from admixture with other forms. All this seems absurdly simple, and it is simple, so much so that it is quite possible of application by a person of average intelligence who has had the proper instruction, but the important point is that it was discovered by the application of thoroughly scientific methods. Nilsson's principle is in very general application to-day and is being used to excellent effect in the improvement of Indian corn in the Middle West.

Contrast with this the methods of Mr. Burbank, whose name is familiar to all. It is not that he should not be given the credit of having established new and useful strains of cultivated plants, or of having done some remarkable feats in the way of plant breeding; but it is that his methods are almost purely intuitive and would die with him, were his own records all that there was to be left behind, a striking difference from the mass of data accumulated by Nilsson. It is the rule-of-thumb method, picturesque but uncertain, as against the surer but less romantic practices of science.

THE SHAPE AND SIZE OF THE EARTH.

By PROF. POYNTING.

WHEN men first began to think of the form of the earth they thought that it was a flat plain on which the mountains were wrinkles. But such observations as the disappearance of mountains below the horizon could not be explained if it were flat, and so even in very early times—2,500 years ago—the doctrine rose that it was a round globe. For 2,000 years this new doctrine had to fight the old flat earth theory, and only finally won about 400 years ago when explorers sailed round the earth.

The stars circle round a point in the sky very near the Pole Star, so near that we may for simplicity regard the Pole Star as always in the same position when looked at from the same place. But if we travel from Birmingham 520 miles north to the Shetland Isles, the Pole Star there stands 7½ deg. higher. If the earth were flat this would mean that the Pole Star was only 3,450 miles from Birmingham, and so if we traveled 520 miles south to Bordeaux, it would not sink so much as 7½ deg., and for each succeeding 520 miles it would sink less and less. But observation shows that it rises or sinks very nearly the same amount for each equal distance traveled north or south. Again, if the earth were flat, the sun would rise at the same instant all over it. But as we cross the Atlantic from England it rises about an hour later for every 600 miles we travel west. The earth is therefore certainly not flat.

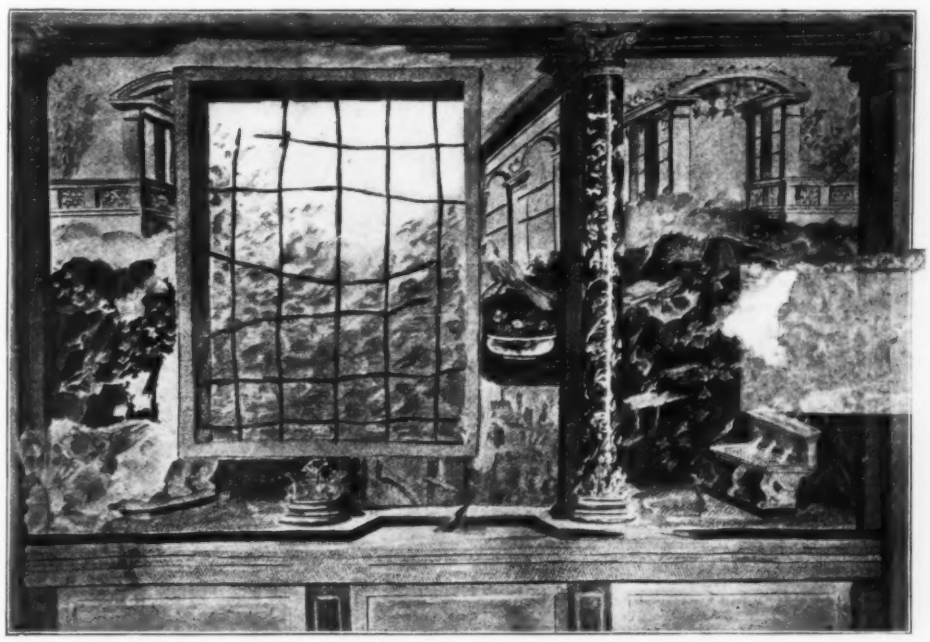
The fact that the stars form the same pattern wherever we view them shows that they are immensely distant, and therefore lines from all points on the earth to the Pole Star have the same direction. The only surface for which the Pole Star would rise an equal amount for an equal distance traveled north is a sphere, and since 520 miles gives a rise of 7½ deg., 6,240 miles would give a rise of 90 deg., or the globe is about 4 x 6,240, or about 25,000 miles in circumference. Again, the only surface which would give the observed equal delays in sunrise as we travel equal distances west is a round globe, and since at the equator we must travel 1,040 miles for a delay of 1 hour we must travel 1,040 x 24, or about 25,000 miles for a delay of 24 hours, or again the circumference is 25,000 miles.

Long distances on the earth's surface are measured by "triangulation." If we know the length of the base of a triangle and the two angles at the base we can calculate the length of the other sides. A base line some miles long is measured by measuring rods on a flat place. From each end the same distant point is observed and the angles which the lines to it make with the base are measured, and so the lengths of the lines are calculated. These two lines serve as new and larger base lines for other points, and so gradually a network of triangles is formed all over the country, all the sides and angles of which are known. If these triangles are plotted on some known scale on paper any distance on the country over which they spread can be measured. The distance for each rise of 1 deg. of the Pole Star can thus be found. Exact measurements show that the earth is not quite round. The length for 1 deg. is rather less near the equator than near the pole, which shows that it bulges out near the equator. Its diameter at the equator is, on the average, about 41,852,400 feet, and at the pole it is about 41,709,800 feet, a difference of 27 miles, or about 1 in 300. The highest mountain is only about 1/1600 of the diameter, and the deepest sea only about 1/1100 of the diameter, so that if a model of the earth were made, the size of a billiard ball, these irregularities would hardly be perceptible, so nearly is it round. Airy's "Popular Astronomy," Lecture II., gives a good account of the investigation of the shape and size of the earth.—Syllabus of a lecture delivered at the University of Birmingham.

AMERICAN SALESMEN.

THE alleged failure of American salesmen in England has recently been a subject of discussion in British newspapers. They hold that Americans are too aggressive. The Iron Age, commenting on the subject, says:

American manufacturers who have been abroad recently state that, from their own observations and experience, there is much truth in the general proposition. The salesman trained in America lacks the patience and indomitable perseverance necessary to obtain an audience with the average British business man. And if successful to this point, he introduces too much of the atmosphere of the United States into the interview. In the evolution of salesmanship in Great Britain, which has already begun, and which must become more and more pronounced with the closer contact of the two great English-speaking nations, the outgrowth should be a pretty good sort of a salesman—a man well bred, courteous, patient, and combining with these excellent qualities the practical and thorough training of his American cousin, with his full knowledge of the goods he has to sell, down through the processes of manufacture, and of how to sell them to the best advantage. The American in the England of the present day can make considerable headway if, as has been frequently pointed out, he does not lay too great a stress on his own nationality, and especially if he will constantly endeavor to adapt himself, always remembering that no radical innovation of method will be tolerated.



PANEL FROM THE CUBICULUM.

THE BOSCOREALE RELICS.

CAPITAINE PRODUCER-GAS-DRIVEN SHIP.

THOUGH producer-gas engines have been brought to a high standard of efficiency for stationary purposes, and are now being extensively adopted, especially in Europe, the application of the system to marine purposes has been somewhat restricted. For the most part such installations have been confined to small craft. Recently some interesting trials have been carried out upon the Clyde with a ship, the reciprocating engines of which were supplanted by a producer-gas marine engine developing the same horse-power. The system adopted is that evolved by the late Emil Capitaine. The first experiments were made with small vessels. The success of the system in these craft resulted in the construction of two units of 500 and 1,000 horse-power respectively. The work was begun some two years ago, but it was found that the necessary modifications were somewhat numerous and involved, in order to adapt the system to the more severe conditions of a ship. Hence considerable delay unavoidably ensued.

For the purpose of experiment the obsolete British gunboat "Rattler," of 715 tons displacement, was acquired. The reciprocating engines and boilers were removed, and the 500-horse-power Beardmore Capitaine producer-gas engines and auxiliary plant substituted. The 500-horse-power unit was selected for the first experiments, since it was considered that herein is used the largest-sized piston deemed possible of safe employment without resorting to water-jacketing. The engine is practically identical with the smaller lower-powered types, the framing consisting entirely of steel plates arranged to transmit the stresses directly from the crankshaft bearings to the cylinder heads, which are the only large parts made of cast iron. The advantage of this design is that a very rigid construction combined with lightness is secured. The engine is of the vertical type with five cylinders, each developing 100 horse-power, working on the well-known Otto cycle. Camshafts for operating the inlet and exhaust valves are disposed on either side of the cylinders and operated by rocking levers, so that when it is desired, the cylinder heads may be easily and quickly removed, and free access to the pistons secured. Two systems of ignition, one the high-tension Lodge, and the other low-tension magneto, are fitted. The cylinders together with the various bearings are lubricated by a system of forced lubrication, a distributor giving a full pressure of oil to each part in turn.

The gas-producing plant is arranged to work with bituminous coal, the producer being fired from the top by means of a mechanical stoker, and the gas drawn from the hottest zone of the producer. As fresh fuel is charged at the top it is preheated by the hot coal beneath, and the gas is supplied pure. The tar products are carried through the incandescent coal at the bottom of the producer. The mechanical stoker is of special design, to prevent the formation of clinker when using bituminous coal and to obviate the caking of the fuel. Before installation in the "Rattler," the engines were subjected to a series of prolonged trials.

It was estimated that by using 500-horse-power producer-gas engines an economy in weight of some 75 per cent would be secured in comparison with reciprocating engines and boilers developing the same power, but in this particular instance the economy obtained was somewhat greater. The weight of the displaced steam machinery approximated 150 tons, while the gas engines, producer, etc., together with the steam donkey boiler that was adopted for working the pumps, steering, and auxiliary machinery, aggregated only 94 tons, showing a saving in weight of some 66 per cent. The donkey boiler is also used for working the compressors by which the engine is started after a long period of rest. When under way this boiler can also be fired by gas from the producer.

The engines are single-acting, the cylinders being of 20 inches bore by 24 inches stroke, and develop the normal 500 horse-power at 130 revolutions per minute. The gas upon its withdrawal from the producer is scrubbed and dried by a patent process evolved by the designers, whence it passes directly to the combustion chambers, the exhaust gases subsequently being discharged through small boilers for raising steam, to be utilized by the producer. The

engine is started by a compression system, a mixture of gas and air being injected up to a certain pressure. The speed of the engine is easily controlled by suitable mechanism, and can be increased or diminished with facility.

One of the most ingenious features of the installation is the transmission of the power from the engine to the propeller shaft, the governing of the engine when the load is applied or removed, so as to prevent laboring or racing as the case may be, and the reversing gear. There is a special type of clutch worked by hydraulic power. When the pressure is applied, the propeller shaft is coupled up to the crankshaft, and similarly when the pressure is released the propeller shaft ceases to revolve, while at the same time the engine governor comes into play, and the engine runs light without practically any increase in speed. The reversing gear for traveling astern is of entirely new design. The engine power in this instance is transmitted to the propeller shaft through a train of wheels or epicyclic gear combined with the clutch, which drives the shaft in the reverse direction. By this arrangement the ordinary type of bevel gearing, etc., usually employed for reversing is dispensed with, as well as feathering propellers.

The trials with the ship were carried out over a period of eight successive days. The runs, however, were not in any single instance of great length, the longest being of 45 knots, during which 1,708 pounds of bituminous coal were consumed, giving an average consumption of 37.94 pounds per knot. No attempts to drive the vessel at its maximum speed were made, but in one run 31 knots was covered against a tide running at 1.5 knots at an average speed of 11.5 knots at 110 revolutions per minute. During the course of these trials with coal costing $3.72 per ton, the fuel consumption averaged 6.46 cents per knot at an average speed of 10.5 knots per hour.

Even at the highest speeds attempted, very little noise was observable in the engine room, while the vibration set up was also very slight. The coal consumption as compared with the steam engines of the same power was about 50 per cent less, while less labor was required in the engine room, and the less space occupied by the equipment was similarly striking. Upon the conclusion of the trials the vessel returned to the business yards, where the engines are to undergo certain modifications which the tests demonstrated as necessary, and will then be submitted to further demonstrations.

ORGANIZED ANARCHY AMONG BEES.*

THE CURIOUS SOCIAL LIFE OF THE BEE.

BY GASTON BONNIER

Bees and their monarchy have often been contrasted with republics. It is now known, however, that the social system of the bees is not monarchy, but socialism—or, rather, anarchy, for there is no evidence of the existence of an administrative or legislative body, commanders or a hierarchy of any kind. If we must distinguish between the social systems of bees and those of ants, in both of which feminism has been carried to the highest development, we may say that ants are individualists and bees are collectivists.

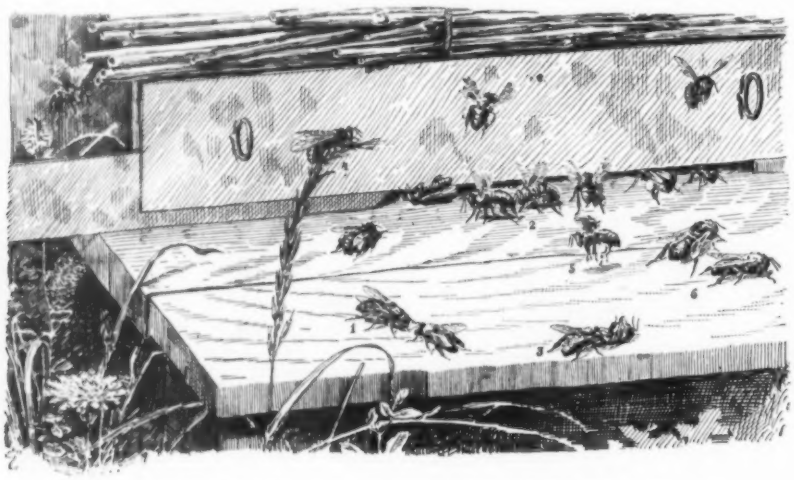


FIG. 1.—BEES OBSERVED AT THE ENTRANCE OF A HIVE.

1. A guard. 2. Ventilators. 3. A scavenger. 4. A harvester resting before entering the hive. 5. A harvester laden with pollen. 6. Drones.

The queen bee (Figs. 2, 4, and 6, *M*) is not only absolutely devoid of authority but she is a mere slave devoted to a single task, the laying of eggs, in which she is guided and controlled by a sort of staff, the members of which are continually changing. The queen is the issue of a normal egg similar to those which produce workers but, instead of being functionally neuter, like these, she is developed into a perfect female by the administration of a special food. The fecundity of the whole colony is thus concentrated in a single individual, and the poor queen, the universal mother, is compelled to lay continually, the number of eggs laid each day being nearly proportional to the quantity of honey collected on that day. At certain seasons of the year she deposits daily 3,000 eggs in as many cells, which are arranged in double layers, back to back, forming the "combs."

FIG. 2.—QUEEN ON COMB.

This mother of her people has gone outside of the hive only once, soon after her emergence from the cocoon, and she will not go out again unless she goes to lead a swarm. With these exceptions she is a perpetual prisoner, tended and pampered by her train of workers, but only on condition that she never fails to lay in the cells as they are pointed out to her in perfectly definite order. If her production of eggs becomes insufficient, for any reason, the workers prepare a new queen to take her place. The condemned queen herself lays, in a special cell, much larger than the rest and of very different shape (Fig. 3, left), the egg which is to produce her successor, the larva which issues from this egg and occupies the royal cell being fed with the special food known as "royal jelly." As soon as the new queen has emerged from the pupa and become pregnant, the old queen, hitherto tended with the most scrupulous care, is ruthlessly sacrificed. Thus is effected what agriculturists call the natural renewal of the queen.

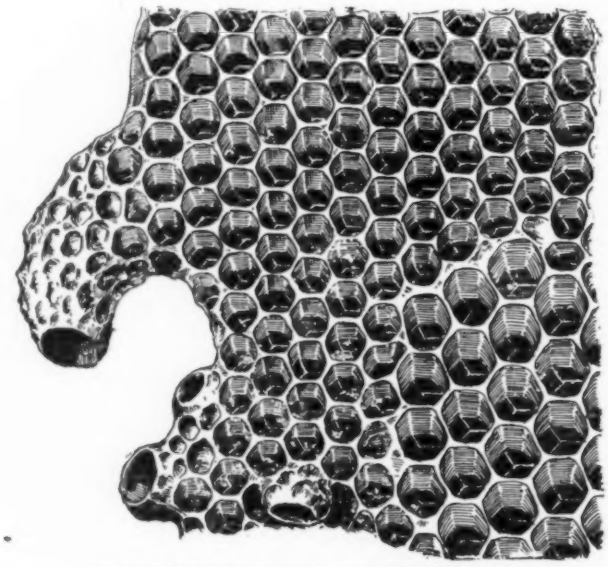


FIG. 3.—BROOD CELLS OF VARIOUS KINDS.

Above, worker cells. In the right lower corner, drone cells. At the left, a finished queen cell. In the left lower corner, unfinished queen cell.

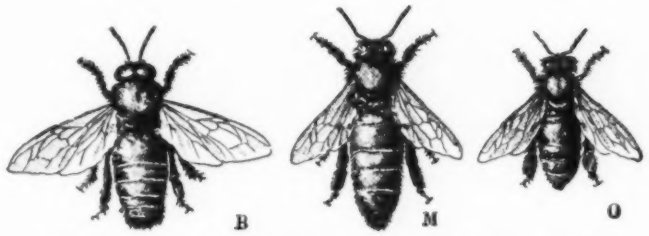
FIG. 4.—A QUEEN LAYING AN EGG IN EACH BROOD CELL.

The sole privilege enjoyed by the queen is that of living (provided that she continues to lay regularly) longer than her sisters or her children. Her life may extend through four or five years. The summer workers live only six or eight weeks, while the winter workers, which have very little to do, may live four or five months.

Nor can a trace of authority or initiative be discovered in the male bees or drones (Fig. 1, 6, and Fig. 5, *B*). Their number, which varies greatly during the

* From American Homes and Gardens. Published by Munn & Co.

season, never exceeds a few thousands, while that of the workers of the hive may be more than a hundred thousand. The drones are usually regarded as mere idlers, forming a sort of inverted harem of no possible use except in the event of a change of queens. But although the drones are unable to collect honey and apparently leave the hive only to get a breath of fresh air, flying about without alighting on flowers, they fill subordinate roles at the height of the honey-gathering season, when on fine days every worker that can be spared from the hive goes out to assist in the harvest. At such times a few of the workers compel the drones to remain in the hive, where their presence maintains the temperature required for the development of the young brood. In this case the drones replace the workers which ordinarily act as brooders.



FIGS. 5, 6 AND 7.—THE THREE KINDS OF BEES FOUND IN EACH HIVE.

B. Male, or drone. M. Queen bee. O. Worker. Magnified.

But, in July and August, when the principal honey season is over and there is no further possibility of a change of queens, either in connection with swarming or because of an insufficient supply of eggs, the male bees have become useless, and as these voracious idlers consume a great deal of honey it would be out of the question to feed them through the winter. Therefore, at the end of the summer or even as soon as the daily harvest has considerably diminished, they are condemned to death by the whole body of workers. There will be time enough next spring to compel the queen to lay drone eggs in cells, larger than worker cells, in which the larvæ can grow to the proper size (Fig. 3, lower right corner). When the execution has been decided on, the workers permit the males to go out of the hive but prevent their return and an unequal struggle, curious to witness, takes place at the entrance of the hive. As the drones have no stings they are inevitably defeated. Some abandon the siege and go away to perish miserably, while others continue the combat until they are driven away, sometimes pierced through and through by the stings of the workers.

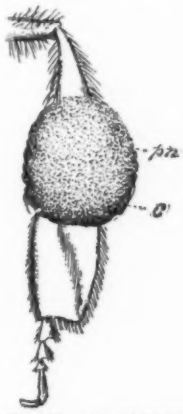


FIG. 8.—HIND FOOT OF WORKER WITH A PELLET OF POLLEN (*pa*) HELD IN ITS CONCAVITY BY BRISTLES (*c*). MAGNIFIED.

Small and compact groups of drones, however, are often seen to force their way through the workers while these are occupied with other drones, and to gain entrance into the hive, whence it is difficult to expel them. If they attempt to climb up the combs to the honey cells above, however, they are promptly thrown down and the massacre continues inside the hive. Sometimes all the intruders are soon killed and their corpses are dragged out of the hive, but if the drones are very numerous the workers may simply keep them prisoners in a corner of the hive until they die of starvation.

Now, when we recall that the workers control the queen's laying and replace her when she fails to lay satisfactorily, and that, at a definite season of the year, they decide to expel the males, we see that of the three kinds of bees in the hive, the queen, the males, and the workers (Figs. 5, 6, and 7), the last form the ruling class.

A question now suggests itself. Are there several varieties of workers or, at any given instant, are certain of the workers in command of the colony?

It is known that the various duties, within and without the hive, are distributed among the workers, and names have been given to different bodies of workers in accordance with the tasks which they are seen performing. Since Huber's investigations, however, it has been admitted that the same worker may successively perform all of these tasks and certain experiments, made by myself and others, which I shall mention presently, prove this general law. But are the differences observed among workers due solely to their respective ages, as most bee-keepers believe?

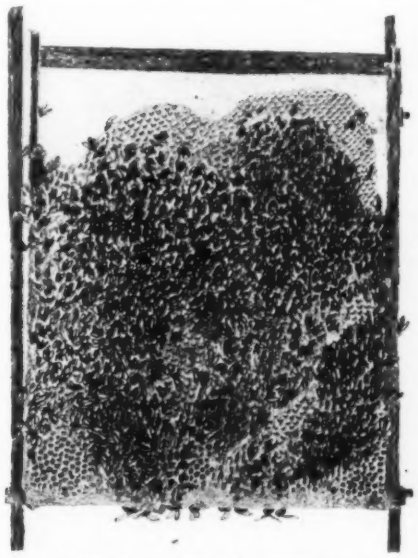


FIG. 10.—A COMB OF BROOD CELLS COVERED WITH BEES ACTING AS BROODERS.

Before answering this question let us classify the principal duties of the bees, both within and without the hive. Merely by watching the entrance of a hive on a fine day in spring we can easily observe that different workers are engaged at very different tasks. In this way we distinguish in a general way the following varieties:

1. The guards (Fig. 1, *1*) which defend the hive from its enemies—wasps, hornets, death's head moths, robber bees from other hives, etc. The guards walk to and fro before the entrance and they appear to be able to summon assistance from workers inside the hive, near the entrance.

2. The ventilators (Fig. 1, 2). These stand with erect legs, often in files which are prolonged within the hive, and keep their wings in continual movement in order to ventilate the hive and remove the water vapor due to the evaporation of the freshly gathered honey.

3. The scavengers (Fig. 1, 3). These are most conspicuous early in the morning when they are seen carrying out of the hive all waste matter and debris, the bodies of bees that have died during the night (the daily mortality may be from 500 to 1,200), badly formed larvæ, etc. The scavengers also kill or expel the ill or wounded workers deemed incapable of further service to the community.

4. The harvesters (Fig. 1, 4 and 5, and Fig. 12).

FIG. 11.—OLD WORKERS, RECOGNIZABLE BY THEIR RAGGED WINGS.

Large numbers of these are observed emerging from the hive, flying swiftly and directly toward their destinations, returning laden with honey and other things, and alighting heavily on the platform of the hive before entering. There is a further division of labor among these harvesters, for the different materials collected for the use of the colony are never brought in together by the same bee.

Most of the harvesters return laden with nectar, which is stored in the crop, or expansion of the alimentary canal. Others bring in pollen which they have gathered from the stamens of flowers (Fig. 1, 5), and packed, in two little colored pellets, in the spoon-shaped hollows of their hind feet (Fig. 8). Still others, especially when nectar is scarce, fill their crops with water which is used to mix with honey and pollen to form the paste on which the larvæ are fed. A few of the harvesters, again, pack their hollow feet, not with pollen, but with a wax-like and adhesive substance obtained from the buds of the fir and the poplar (Fig. 9). This is the raw material of the "propolis," with which the combs of wax are attached to their supports. Finally, if the bees that leave the hive early in the morning are observed with care, it will be discovered that some of them, instead of going directly to definite objective points, fly about irregularly, making a peculiar sound with their wings. They are the explorers which examine all plants and other objects in search of substances worth gathering.

In the interior of the hive the duties of the bees are even more diversified. We may distinguish: the wax workers which, clinging to each other in regular clusters, knead the wax secreted between the segments of their abdomens and construct cells of various types; the nurses, which assemble on the combs over the cells which contain cocoons and thus maintain the temperature required for pupation (Fig. 10); and the store keepers, which fill cells with honey containing not more than 25 per cent of water, adding an antiseptic to prevent fermentation, cover the filled cells with wax, etc.

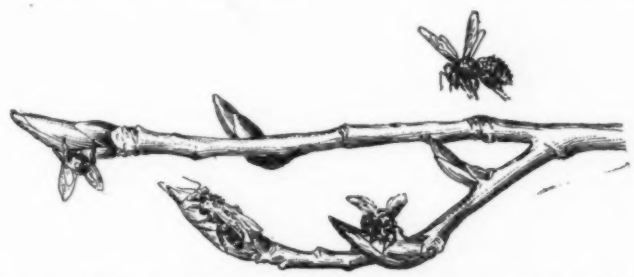


FIG. 9.—BEES GATHERING PROPOLIS FROM POPLAR BUDS.

FIG. 12.—A HARVESTER VISITING A BLOSSOM OF VIPER'S BUGLOSS (ECHIUM). MAGNIFIED.

A classical experiment by Doenhof proves clearly that the same bee can discharge successively all the duties which have been enumerated and that, in general, the younger bees act as guards, ventilators, and wax-workers, and the older bees as harvesters and explorers. In regard to the nurses and brooders, Doenhof's observations are not free from uncertainty.

The experiment was made by replacing the queen

of a hive of common black bees with a laying Italian queen. The Italian or ligular bees are easily recognized, even at a considerable distance, by the yellow color of the first three segments of the abdomen. The new queen at once began to lay eggs of the Italian bee in a hive that contained only the common black bees.

Three weeks after her introduction the first yellow bees emerged from their cocoons. By following the development of the new population it was learned that all Italian bees, during the first fortnight of their adult life, were assigned to various occupations within the hive and at its entrance, but did not go to the harvest field, so that in the two weeks following the appearance of the first yellow bees not one such bee was seen gathering nectar or pollen.

M. de Layens and I repeated this experiment with the same result, but we also discovered a very remarkable fact while we were closely watching a hive, which contained no Italian bees more than two weeks old, on a sunny day when the bees were engaged in the exercise which bee-keepers call the "pin-wheel." In this curious performance numerous workers fly in smaller or larger circles about the entrance of the hive toward which their heads are always turned. The observation was made about ten days after the preparation of the first Italian bees. None of them had yet gone out to gather honey but the pin-wheel was found to consist almost entirely of them, though it also contained a few black bees, which, being the offspring of the deposed queen, were necessarily older than the Italians. When the pin-wheel broke up several of these black bees, after resting for a moment on the platform, flew straight to the harvest field, but all the younger yellow bees re-entered the hive.

This observation shows that the pin-wheel is an exercise in which the younger workers, before they are old enough or strong enough to go out to gather honey, learn to recognize the entrance of the hive and its surroundings. It appears to prove also that the exercise is performed under the direction of older workers, familiar with the entrance of the hive, which return to their task of harvesting as soon as the exercise is finished.

A few days later we saw a few Italian bees beginning work as harvesters. Following them from flower to flower we observed that they alighted with hesitation and often walked around a corolla without extracting nectar. They did not collect nectar in the normal manner until two weeks after preparation. From all this we may conclude that young bees are not able to go out and become expert harvesters at the first attempt. They have to learn to gather honey as they previously learned to perform various duties in the interior of the hive.

In regard to the nurses which feed the larvæ and the brooders which keep the brood warm, assist the young bees to escape from their cocoons, brush them, clean them and unfold their wings, bee-keepers are not agreed concerning the relation which exists between the performance of these functions and the age of the bee. As a matter of fact, there is no such relation. If the brood is very numerous bees of all ages may act as nurses and brooders, and we have seen that even the drones are pressed into service as brooders in the busiest harvest season. In experiments similar to those described above I have observed that during the first week after the appearance of the Italian bees, before one of them had left the hive even for the pin-wheel exercise, a great many of these young Italians acted as brooders, with the assistance of very old black workers, whose age was indicated by their ragged wings (Fig. 11).

It appears, then, that the comparatively easy duties of the brooder and the nurse are discharged, as a rule, by newly-born workers too young to act as harvesters and by old, worn-out workers, which have ceased to be useful except as sources of heat.

All the preceding remarks relate to the regular work of the colony. But what will happen if an unusual and unforeseen event transpires?

I have often repeated the following experiment: Frames filled with pieces of perfect comb, fastened with twine, are placed in a hive. Now, the bees have never seen twine in the hive, where its presence appears to them intolerable, so, after partly destroying and reconstructing the pieces of comb thus secured, and fastening their edges with propolis, they gnaw the twine with their feeble mandibles. When a piece of twine is gnawed off and falls to the floor of the hive, the workers drag it outside and place it parallel with the edge of the alighting board. Then five or six workers arrange themselves at nearly equal distances along the cord, seize it with their mouths and fly away with it to a safe distance from the hive, where they let go simultaneously and drop the cord to the ground. In this operation it is impossible to detect anything like a command or to distinguish any "forewoman" in the little band of workers.

In conclusion, I will describe an experiment which I made last year relative to the communication of information by one worker to another. I placed a drop of honey on the mouth of a nectar-bearing flower much frequented by bees and from it laid a train of honey to a much larger drop some distance away. The bees which came successively to the flower in search of nectar at first paid no attention to the honey, for bees are not easily turned aside from the particular task in which they are engaged. An hour and a half elapsed before one of the harvesters perceived the honey and discovered the large drop. Beside this she remained, drawing honey, for more than three minutes, during which I marked her abdomen with colored talcum powder. She went to the hive and in six minutes returned directly to the site of the drop, which I had renewed during her absence. After she had made several such journeys I saw the same marked bee return, accompanied by two recruits. I marked these also and deposited several drops of honey around the spot. The number of recruits increased. In three-quarters of an hour I had marked fifteen bees which continued to bring others to the spot, for I constantly replenished the store of honey. All these bees were from the same hive, in which some signal must have been given, for suddenly thousands of bees issued from the hive and darted toward the scene of the experiment. Finding the honey exhausted, they flew about in all directions, making with their wings the peculiar sound that indicates anger, and I barely succeeded in escaping their stings.

This final result was lacking when the experiment was repeated with syrup instead of honey. What, then, had occurred in the case where honey was used? Evidently this: The workers in the hive, seeing honey brought in for a considerable length of time, must have reflected that, in the course of nature, honey is found only in bee hives. Hence there must be a hive to rob. Therefore war must be declared and a large force must be sent promptly to destroy the weak hive and capture its store. So the bees rushed *en masse* to the scene of pillage, guided by the marked bees which alone knew the way, and which I saw arrive in advance of the rest. Finding neither hive nor honey, the disappointed marauders, ready for combat, gave way to excitement. Half an hour later order was completely restored.

This experiment, which is susceptible of various modifications, shows clearly that the workers have some means of communicating information and of directing each other to places where useful substances are to be found. It proves, also, that the united workers of a hive are able to make a sudden decision and act as a body when circumstances demand such action.

It appears, therefore, that the power to direct the daily work and to form resolutions in unforeseen circumstances resides in the entire community. There is universal participation in government, a marvelous organization of anarchy.—Translated from La Science au XXme Siècle.

CAISSON DISEASE.

THE ILLS OF COMPRESSED AIR.

THE recently issued British "Report of the Health of the Navy" contains an interesting memorandum prepared by Staff Surgeon-General Rees on the subject of "Caisson Disease," an abstract of which is given herewith. The memorandum deals chiefly with the disease so far as it affects divers, but is also applicable to all cases where compressed air is used.

As a diver descends in the water, air is pumped to him by means of an air pump, which keeps the air pressure in the helmet approximately equal to the water pressure at the level of the exhaust valve of the helmet. It is seldom that a caisson worker is subjected to a greater pressure of air than 40 pounds, while the diver at 35 fathoms is exposed to a pressure of 93.6 pounds per square inch.

A gas in contact with a liquid on which it has no chemical action is absorbed by the liquid in amounts proportional to the pressure under which the gas is at the time. In the lungs the air is practically in contact with the blood. In a mixture of gases each gas is absorbed by the fluid as if it alone were present. Each of the gases forming the mixture of atmospheric air, viz., oxygen, nitrogen, and carbon dioxide, is absorbed in accordance with this law, but the oxygen is used up by the tissues, and the ventilation of the lungs is such that the CO_2 is kept at a fixed percentage, no matter what amount is present in the air breathed. The nitrogen is absorbed unaltered, and in an amount in direct proportion to the pressure. Dr. Hill has shown by experiment that the amount of nitrogen absorbed by the blood under pressure conforms to Dalton's law. So long as the diver remains under pressure there is no manifestation of the presence of the absorbed gas, but as soon as the pressure is released, the gas will begin to bubble off. Fortunately, the blood is a sticky albuminous fluid in which bubbles do not easily form, and is capable of being supersaturated with nitrogen to twice its normal amount without the formation of bubbles. It has been found recently that fat can take up six times the amount of nitrogen as the same weight of blood.

The comparative freedom of the diver from attacks of "the bends" is probably accounted for by the fact that his blood never becomes saturated, owing to the limited time he is exposed to compression.

The relative immunity of divers to caisson disease varies. Dr. Snell has pointed out how much more liable the old are than the young to illness from this cause. In cases collected by him, the percentage ratio of illness at each age was as follows:

Age.	Per cent of illness.
20 to 25	10.3
25 to 30	24.3
30 to 35	20.9
35 to 40	22.9
40 to 45	26.3

The increase in the percentage of those attacked by the disease after the age of 45 is so excessive as to make it extremely dangerous to employ men who have reached that age.

The following table, compiled by Mr. A. Smith, indicates the influence of bodily habit on health:

	Spare.	Medium.	Heavy.
Men who lost little or no time from sickness.	25	14	3
Men taken sick.....	26	22	36
Men paralyzed	2	3	8
Men died	—	—	3

These figures suggest the desirability of eliminating fat men from those exposed to compressed air, and are in accordance with the results to be expected from a scientific study of the disease. A man who carries about with him a huge reservoir for nitrogen, as is provided by the abdominal fat, must be more liable to the formation of bubbles than the thin, spare man. In fatal cases after sudden decompression bubbles have been found in the abdominal fat when there were none found in other tissues.

Safety in decompression may be secured by two methods: (1) Limiting the time of the exposure; (2) by bringing the diver up slowly. In caisson work it has been found that by limiting the time of the exposure to the compressed air, cases of paralysis have been practically eliminated.

Various rates of decompression have been suggested. Paul Best recommended a rate of twelve minutes for each atmosphere of pressure; Hiller, Meyer, and Von Schrötter, twenty minutes per atmosphere; and Hill and Macleod the same rate. The blood, as it leaves the left side of the heart, is always saturated with air to the existing pressure, and, in the same way, will be desaturated to the same pressure. The blood leaves the arteries in less than half a minute, and in this time bubbles scarcely seem to form, so that there will be little risk of their actual formation in the arterial blood unless ebullition is practically instantaneous. With very rapid decompression, however, small bubbles which have passed through the capillaries of the lungs may easily increase in size in the arteries.

If we had only to consider the saturation of the blood by nitrogen, the problem of safe compression would be easily solved. The whole of the blood passes through the lungs once a minute, and as it is at once desaturated to the existing pressure, all danger would pass away one minute after sudden decompression.

Unfortunately, the problem is much more complex, as the saturation of the tissues has to be considered. Experience shows that cases of accident are almost non-existent when the air pressure is less than 20 pounds plus, and it would seem that this immunity is due to the fact that bubbles will not readily form as long as the relative diminution of pressure is kept at a ratio of 1–2. In coming up from—

33 feet to the surface,
or from 99 feet to 33 feet,
or from 165 feet to 66 feet,
or from 231 feet to 99 feet.

—there should be no formation of bubbles, and generally decompression can be safely proceeded with if the difference between the relative pressures of the air and nitrogen dissolved in the blood and tissues is not more than in the proportion of about 2 to 1. This assumption is of great practical importance, as desaturation will naturally go on faster the greater the relative difference we can establish without undue risk. In gradual and equal decompression the absolute difference between the air pressure and the nitrogen pressure in the tissues necessarily goes on increasing, and is greatest at the end of the process. When we take into consideration that it is the relative and not the absolute difference in the nitrogen pressure that matters, the unsuitability of uniform decompression becomes more evident.

Acting on the above consideration, a scheme of decompression of the diver in stages has been drawn up. Many experiments have been carried out at the Lister Institute by Dr. Boycott and Lieut. Damant, R. N., to compare the two methods of decompression, and the great advantage of the "stage" method has been conclusively proved.

It was found that the time required to desaturate a diver who was completely saturated with nitrogen at 41 pounds pressure (95 feet) was at least 90 minutes. In 30 fathoms, or 80 pounds, 3¼ hours would be required. Such a length of time is impossible for the diver, so it was found necessary to limit the extent of saturation. A table has been prepared giving a scale of times that divers may be allowed to stay in deep water.

Bubbles once formed in any tissue of the body are liable to increase in size as long as the pressure of nitrogen in that tissue is greater than that of the air. This will account for the fact that symptoms may go on increasing in intensity for two or three hours after decompression.

Although Dr. Rees's memorandum deals primarily with caisson disease as affecting deep sea divers, the conclusions of the committee, which he summarizes, apply in like manner to the conditions obtaining in caisson and other forms of compressed-air working.

The researches of Drs. Hill, Haldane, and Greenwood, Lieut. Damant, and others have completely revolutionized the practice of compressed-air working in the last few years. It is now possible to carry out operations under air pressures and at depths formerly out of the question, provided due precautions and suitable methods of working are adopted. Lieut. Damant, the recently appointed British naval inspector of diving, has descended to a depth of 210 feet without detriment to health. This depth undoubtedly constitutes a record in diving work.—The Engineer (London).

A ROTARY FIELD MODEL.*

HOW ELECTRICAL THEORIES MAY BE EXPERIMENTALLY ILLUSTRATED.

BY R. H. FLOERING.

THE well-known wave diagrams employed to illustrate the theories of electromotive forces or currents might be called bird's-eye views of the rising and falling electromotive forces or currents. The set of figures (usually eight in number) commonly used to illustrate the production of the rotatory field are snapshots, so to say, taken at 0 deg. (360 deg.), 45 deg., 90 deg., etc., of the cyclic period, showing the relation between current and magnetic flux at the respective movements. Useful as the figures are, they lack life, and in the latter case the snapshots do not show the value of the wave clearly. In the following description an attempt is made to combine the bird's-eye view and snapshots with mechanical motion so as to obtain a "live" model, showing the lively state of affairs as found in a live machine in a way that imitates the doings of the machine more closely than can be done by means of motionless figures. The rising and falling of the waves can be seen simultaneously with the resultant rotatory magnetic flux; not by leaps and bounds, not at eight definite instances only, but uninterruptedly.

For the sake of simplicity and brevity, the case of a two-phase induction motor is considered. The wave of the electromotive force (or current) is drawn on a circle (*C*—*C*) instead of on a straight line, for a base line. The value of the sine, as found in the inner circle, is added to the respective radii of *C*—*C*, and a smooth curve is drawn through the free ends of the transferred sines, thus giving the sine wave. The dotted lines, being merely construction lines, are not essential parts of what we will call the wave dial (Fig. 1).

Fig. 2 shows the stator dial. This must correspond to Fig. 1 in size: *C'*—*C'* = *C*—*C* of Fig. 1. The windings of the two phases are supposed to be concentrated in two coils which, of course, are at right angles to each other. They are represented by slots *a* and *a'* for phase *A*, and *b* and *b'* for phase *B*. The length of

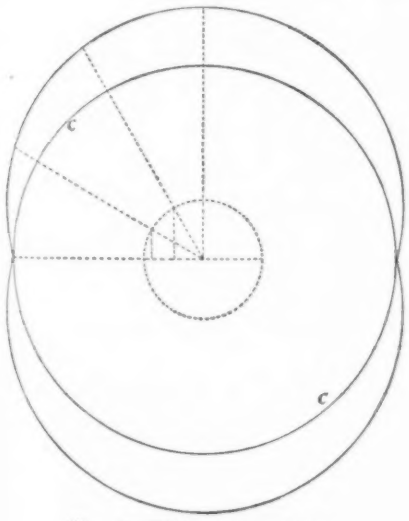


FIG. 1.—THE WAVE DIAL.

these openings in the stator dial must be equal to the radius of the dotted circle in Fig. 1. In these slots the rising and falling of the waves is seen. They are filled at 90 deg. and 270 deg., half-filled at 30 deg. and 150 deg., and bare at 0 deg. (360 deg.) and 180 deg. of the cycle, and so on.

In order to distinguish readily between positive value (elevation) and negative value (depression) of

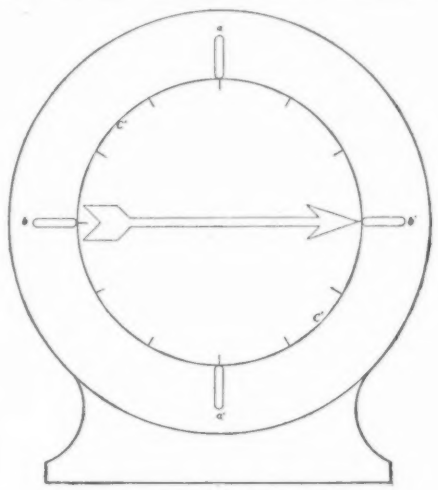


FIG. 2.—THE STATOR DIAL.

the waves, in other words, up-flowing and down-flowing currents, the crescents in Fig. 1 should have different colors, one for positive, the other for negative values.

The wave dial is mounted centrally behind the stator dial on a spindle which extends through a central opening in the stator dial and carries an arrow, as shown, which must be placed so that it indicates the direction of the magnetic flux in the rotatory field. The vane locates the *N*-polarity, the head the S-polarity of the stator ring.

Reversing the direction in which the wave dial is turned shows that reversing the connections of one phase causes the magnetic flux to rotate in the opposite direction. Three-phase operation may be illustrated by a model of this kind by making the proper changes. The model also permits of several alterations being made to suit personal fancy. As shown in Fig. 2, the degrees, every 30 degrees for instance, may be indicated on the stator dial for referring to the value of the wave for fractions of the cycle. Wave forms distorted from the dial sine curve may be plotted.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE CONVERSION OF THE DIAMOND INTO COKE IN HIGH VACUUM BY CATHODE RAYS.*

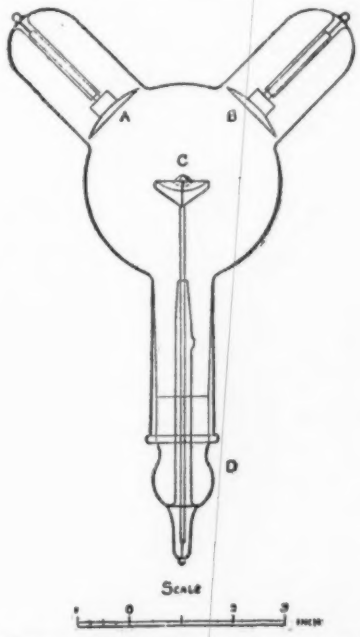
By Hon. CHARLES A. PARSONS, C.B., F.R.S., and ALAN A. CAMPBELL SWINTON.

THE objects of the experiment were threefold: first, to ascertain whether a diamond could be entirely converted into coke or graphite by heating in a vacuum by cathode rays; secondly, in the event of this being found practicable, to make a determination by Féry's optical pyrometer of the temperature at which the conversion takes place; thirdly, to endeavor to ascertain if, during the conversion, any gas was emitted or absorbed by the carbon.

The vacuum tube employed is shown in the illustration, where *A* and *B* are the two aluminium electrodes, *C* the diamond, and *D* an air-tight ground-glass stopper joint, through which the diamonds were introduced. Alternating current was employed, each of *A* and *B* acting as cathode and anode in turn, while their concave curvature was such as to accurately focus the cathode rays onto the diamond. The latter was supported on a plate of iridium, which, in turn, rested in a platinum cup, this arrangement being designed to prevent any stray cathode rays which might miss the diamond from striking the glass walls of the tube and melting the latter. During the experiment the tube was connected to two mercury pumps of the Toepler type, and in connection with the tube there were also attached two spectrum analysis discharge tubes for the purpose of collecting and examining some of the residual gas in the tube, both before and after the conversion of the diamond into coke.

The alternating current from the mains, which was of eighty-five periods per second, was passed through the primary of a 10-inch Ruhmkorff coil, with the contact-breaker and condenser disconnected, with an adjustable choking coil in series in the primary circuit, so that the secondary voltage could be varied from about 5,000 to 12,000 volts. A reflecting milliamperemeter was employed to read the current through the tube, while the volts across the tube's terminals were measured by an electrostatic voltmeter.

Two diamonds, each about 0.2 inch in diameter, were experimented with. The first was entirely converted into coke without difficulty, while in the case of the second the process was stopped when most of it had been so converted, the residue being black throughout its mass. As the proper degree of vacuum was reached



VACUUM TUBE FOR CONVERSION OF DIAMONDS INTO COKE.

by working the mercury pumps, and as the volts were raised, the diamond in each case became red, and then intensely white hot, till, with about 8,000 volts and 44 milliamperes (352 watts) passing through the tube, the diamond began to throw off small sparks. On the volts being increased to 9,600, and the current rising

* Proceedings of the Royal Society.

to 45.5 milliamperes (436 watts), the sparks thrown off became more numerous and the diamond commenced to become black. Finally, with 11,200 volts and 48 milliamperes (537 watts), a rapid disintegration of the diamond took place, with considerable increase in volume, the residue having much the appearance and consistency of coke.

The temperature of the diamond, as given by the pyrometer during disintegration, was 1,890 deg. C.

During the heating up of the diamond and of the tube, large amounts of gas were driven off, and had to be pumped out, but there was nothing to indicate that any of this gas originated from the diamond rather than from the metal parts and glass walls of the tube. Two experiments were made, and in the latter there was distinct indication of a rise in vacuum just about the time of the conversion. These rises in vacuum are, however, not unusual in tubes in which there is highly heated metal, and it was impossible to decide whether any of the absorption of gas took place in the diamond.

In the experiment in question, one of the spectrum discharge tubes was sealed off just before the conversion, when the diamond was commencing to blacken on the surface, while the other was sealed off after the diamond had been converted into coke. These two tubes, therefore, respectively contained samples of the residual gas before and after the conversion. Their spectra have been photographed alongside of one another, but though they are not altogether the same, the differences do not appear sufficiently marked to determine with exactitude any variation in the nature of the gases present.

A SALVAGE DOCK FOR SUBMARINES.

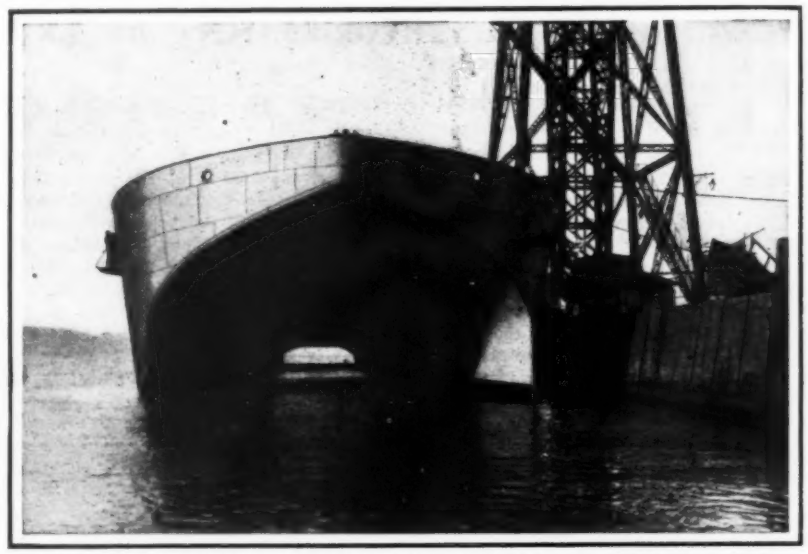
HOW SUBMARINES MAY BE RAISED.

BY THE BERLIN CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

Owing to the many accidents to submarines that have occurred in the course of the last few years the navy authorities of different countries have turned their attention toward designing a suitable means for raising and docking such boats. In the case of both the French and English submarines that have met with disaster, floats were used for lifting the vessels. The floats were submerged and chains were passed beneath the hull of the wreck. On pumping out the water in the compartments of the floats, the wreck was raised and then hauled into a drydock, after which the submarine was blocked, the floats were removed, and the dock pumped dry before access could be had to the damaged vessel. It will be very evident that this process is a laborious one, especially the task of passing the chains under the hull, and to expedite matters it has been the recent practice to fit the submarine with rings so as to provide means for attaching the chains in case of accident. In order to further simplify the process of docking a wrecked submarine a special salvage dock has recently been constructed for the German navy. A similar dock is nearing completion in France. Both docks are constructed like ordinary drydocks with a central floor flanked by compartments on opposite sides which may be filled or emptied according as the dock is to be submerged or floated. In the case of the "Oberelbe," namely, the German dock just referred to, this central floor is removable, the compartments at each side being rigidly connected to each other by cross beams. The dock is provided with powerful cranes and tackle operated by electricity. In one of the compartments is a generating set which furnishes the required current.

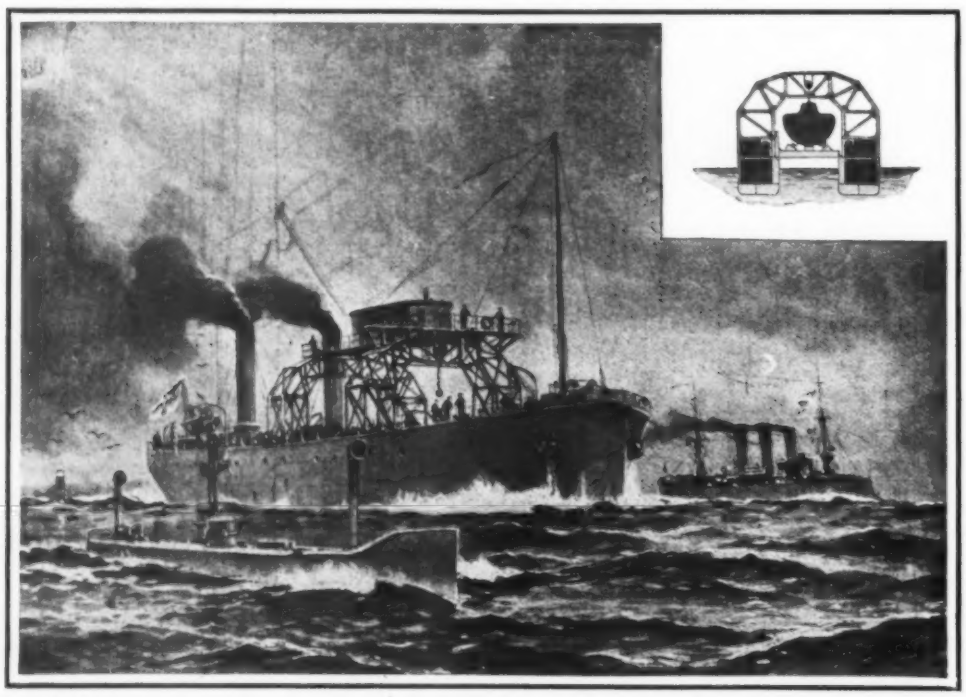
When raising a wrecked submarine the floor of the dock is removed and the dock is about two-thirds submerged. The submarine is then lifted by means of the cranes while the compartments of the dock are emptied. When the hull reaches the surface the floor is slipped beneath it. This done the dock is pumped dry.

In order to facilitate the towing of the dock toward the site of the accident, it is fitted with a sheet metal bow and stern which at the same time serve to reinforce the structure. The "Oberelbe" is 230 feet in length, and will lift 500 tons, while the French dock now building will be 262 feet in length, and of 900 tons capacity.



THE "OBERELBE"—A GERMAN SALVAGE DOCK FOR SUBMARINES.

Length, 230 feet. Capacity, 500 tons.



Illustrirte Zeitung.

THE GERMAN FLOATING SHELTER FOR SUBMARINES.

AEROPLANE DESIGN.

In the course of the discussion on a paper on "Aerial Navigation," recently read before the Junior Institution of Engineers, Capt. Ferber, of the French Military School of Aeronautics, gave certain formulas as being adequate for the design of any type of aeroplane. The resistance of the air could be obtained from the equation

$$P = 2\,K\,S\,V^2 \sin\theta,$$

where θ was the angle of impact, S the area of the surface in square meters, V the velocity in meters per second, and K a constant. P would then be the pressure in kilogrammes. As θ was difficult to measure, the expression

$$P = K^1\,S\,V^2$$

might be used, and would be near enough for practical purposes if K^1 were taken as $= 0.06$. It will be noticed, as Capt. Ferber pointed out, that this gave results about eight times more favorable than those in the generally accepted table of Herbert Chatley; and thus, contrary to general belief, an aeroplane could be made to fly fairly easy.

It seems generally accepted that, with aeroplanes as at present constructed, the total area in square feet should be about half the total weight of machine and load in pounds; or, in other words, that 2 pounds may be supported per square foot of area. This ratio was given by Mr. Herbert Chatley, in his paper above referred to, and he illustrated it by quoting examples of successful machines. Farman's machine, if the figures published are correct, has a net weight of 1,100 pounds, and an area of about 690 square feet, so that, with a man on board, the ratio of weight to area would be about 1.6. The comparison of these proportions with those that obtain in the case of flying creatures is probably of more interest than practical value, as the proportional wing area of the sparrow is twice that of the pigeon, while the pigeon has, weight for weight, twice that of the stork, and so on. M. de Lucy has given the proportions for various insects and birds, the heaviest of which is the strong-flying Australian crane. This bird has the least wing area in proportion to weight of all those measured, the wing surface supporting about 2.4 pounds per square foot.

The tractive force F to maintain horizontal flight might vary from one-third to one-fifth of the weight of the machine; a quarter was a fair value; but if a third were taken, there would be no doubt of the rising of the machine from the ground. Assuming a propulsive efficiency of 50 per cent, and a tractive force of one-quarter the weight, the horse-power then works out at

$$\text{H.P.} = P\,V/150.$$

For the design of aerial screws the following formulas were given by Capt. Ferber:

$$F = a\,h\,r\,n^2\,d^4$$

$$L = (B\,h^2\,r + B^1)\,n^2\,d^5,$$

where F is the pressure in kilogrammes, L the work in kilogramme-meters, n the revolutions per second, d the diameter in meters, h the ratio of pitch to diameter, r the slip, and a, B, and B^1 coefficients depending upon the screw employed. In screws used by Capt.

Ferber for aeroplane-driving the coefficients had the following values: $a = 0.033$, $B = 0.027$, $B^1 = 0.003$.

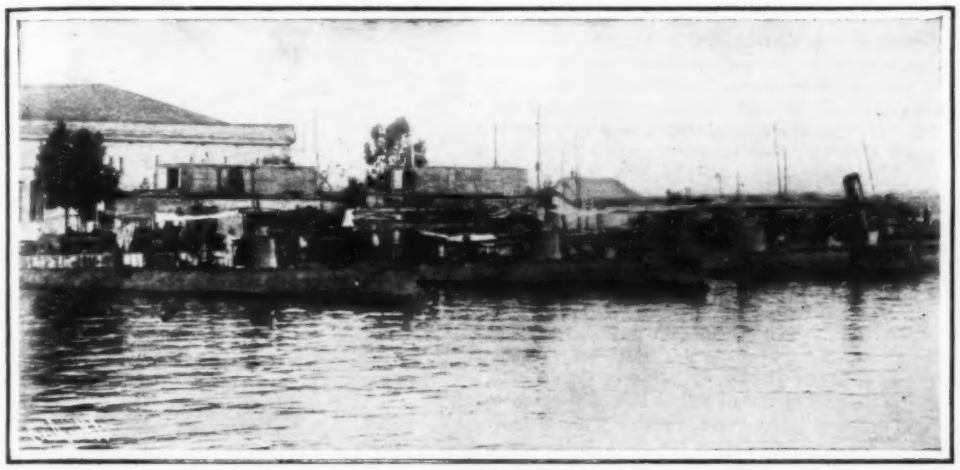
Major B. Baden-Powell made the striking statement that a plane surface, set at what may be called a negative angle of lift, had, nevertheless, been found to rise when pushed forward. If this is confirmed—and the Major showed an experiment which seemed, to some extent, to substantiate it—it is another example of how very little is really known about the action of aeroplanes. There is an enormous amount of practical experimenting to be carried out before we are sure that we are working on the right lines of design; as, unfortunately, the mathematical theories so far propounded are absolutely unreliable, owing to want of sufficient and accurate data.—Engineering.

ITALIAN SUBMARINES.

AN ACCOUNT OF SOME LARGE SUBMARINES.

BY R. G. SKERRETT.

IT is not commonly recognized how rapid and brilliant have been Italy's strides in the direction of submarine navigation. While most other nations engaged in like work have permitted a good deal of spectacular publicity, Italy has gone along in a quiet and unobtrusive manner with some experiments that have quite revolutionized the accepted standards in this fairly new branch of naval architecture.



A GROUP OF ITALIAN SUBMERSIBLES AT TARANTO.

From the first Italy has stood for the submersible, and the boats now possessed by Italy are typical of all that is best in this particular type of under-water craft.

The "Delfino" was the first of Italy's modern submarines. She was built in 1889. At that time she was a cigar-shaped craft, propelled by electricity, and fitted with two 14-inch torpedo tubes. Her speed on the surface was but 5 knots, and when submerged she could not exceed 2 knots. To enable the boat to sink on an even keel, and in fact to control her submergence, she was fitted with a couple of propellers set in vertical tubes running through the boat, somewhat after the plan adopted by Nordenfelt in his boat built for the Russian government, generally known as "Nordenfelt IV."

While the results obtained with the "Delfino" in her original form were not altogether satisfactory, still she provided a fund of practical data which was properly estimated by the Italian authorities, and afforded a safe foundation for further development and trials. From 1889 until 1901 the "Delfino" was used for extensive experimentation, the results of which were carefully kept secret by all of the officials concerned. In 1902 or thereabout the "Delfino" was considerably modified and underwent extensive improvements in a number of directions. As originally built, her upper-hull plating was made considerably heavier than the rest of her spindle-shaped body. In rehabilitating the craft, this heavy hull plating was removed and a great saving in weight thus effected, which was promptly put to better and more telling use in other directions. A set of up-to-date accumulators were installed in place of the old battery, and explosive motors were provided for the purpose of supplying power for surface propulsion. This gave the "Delfino" dual means of propulsion, the electric power being for submerged work only. The spindle-shaped hull had proved an undesirable form for surface navigation, and to make the boat more weatherly she was fitted with a superstructure something after the fashion of that now fitted on the British and American boats of the "Holland" type. Thus modified and modernized, the "Delfino" possessed a surface speed of 8 knots and a submerged speed of something over 6 knots. Two 18-inch torpedo tubes supplanted the two old 14-inch tubes, and altogether the "Delfino" has since shown herself to be an efficient and reliable craft.

The valuable information secured in the gradual evolution of the "Delfino" formed the groundwork upon which Engineer Cesare Laurenti built in designing his boats of the "Glauco" type. These were launched successively in 1905, 1906, and 1907. They are 118 feet long, have a maximum beam of a trifle over 13 feet, and a surface displacement of 150 tons. They are said to have developed a speed of 14 knots when running light upon the surface and a speed of 8 knots when running submerged. In the summer of 1906 these boats took part in the Italian naval maneuvers, and their performance was highly satisfactory during their work both by day and by night. Their mobility was amply demonstrated during the run from Venice to Taranto, which they made without convoy and entirely under their own power. Their part in the maneuvers consisted principally in making attacks upon anchored ships guarded by a large flotilla of torpedo craft. The "Glauco" and "Squalo," while running at depths of from 10 to 20 meters, experienced no difficulty in passing through the narrow strait of San Vito and reaching the anchored battleships without once being detected by the guarding flotilla. These achievements, and the facility with which the boats were handled after only a short period of training on the part of their crews, gave the amplest evidence of the degree of perfection reached in the design and construction of these vessels. It is the best sort of proof that the submerging boat in contradistinction to the diving boat is by far the easier craft to learn to handle; and this point has an important bearing upon the wartime usefulness of such vessels, when rapid changes or substitutions in the crews may become necessary, and the ease with which a stranger may take up this work will mean everything to the military usefulness of such craft.

In addition to the "Glauco" and "Squalo," the Italian government now has three other sister ships, namely, the "Narvalo," the "Otaria," and the "Tricheco." With these vessels the Italian government recently has been carrying on a further series of experimental maneuvers, and from authoritative sources it is learned that their performances have served to still further emphasize the advanced position taken by Italy in the direction of submarine navigation.

Engineer Laurenti now has other boats under construction for the Italian government as well as for some northern countries. These boats are being built at Spezia at the shipyard of the Fiat-San Giorgio, the latter yard having gone in for specialism in the matter of submersible submarine torpedo boats.

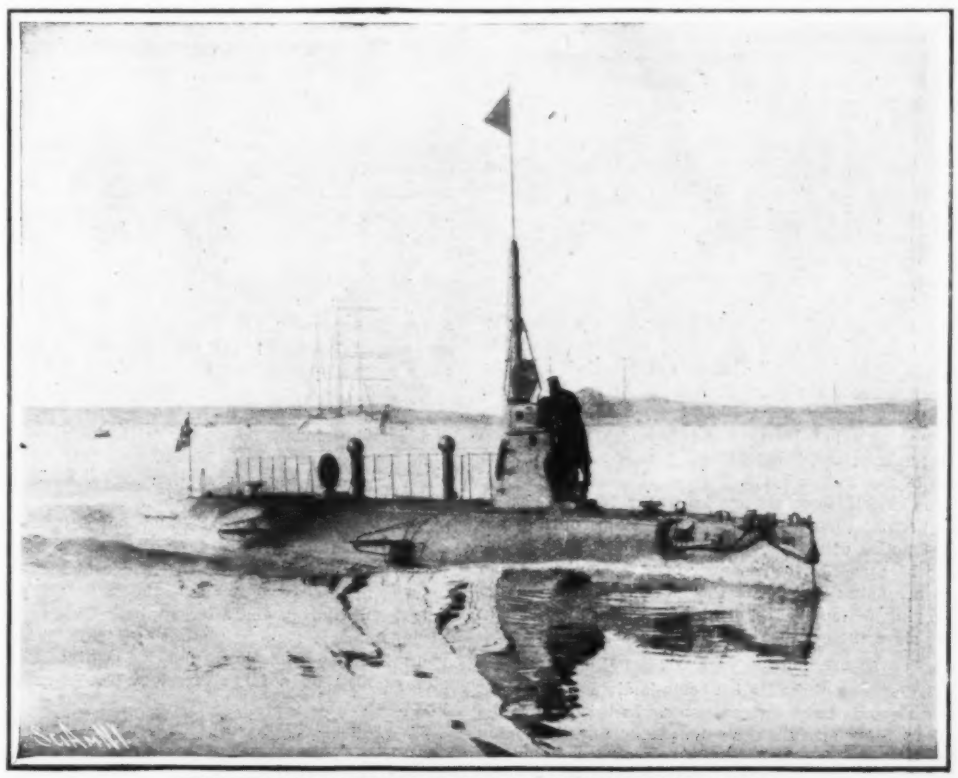
Some very interesting details regarding these vessels have leaked out. The boats have the following principal dimensions and general characteristics:

Length over all	139 feet 4.5 inches.
Beam, extreme	16 feet 10 inches.
Freeboard (hull)	3 feet 11.25 inches.
Freeboard (hatch coamings)	5 feet 4.75 inches.
Freeboard (to top of conning tower)	10 feet 9.75 inches.
Draft (surface trim)	6 feet 11.5 inches.
Displacement, surface, when fully laden	180 tons.
Displacement, submerged	230 tons.
Safety drop keel	12 tons.
Reserve buoyancy in light condition	60% of displacement.
Metacentric height, surface trim	19.6 inches.
Metacentric height, submerged	11.8 inches.
Number of bulkheads	8
Hull designed to withstand submergence to depth of	150 feet.
Maximum power of explosive motors	750 horse power.
Maximum power of electric motors	190 horse power.
Number of propellers	3
Surface speed, maximum	15 knots.
Submerged speed, maximum	9.9 knots.
Surface radius of action at 8 knots speed	875 nautical miles.
Submerged radius of action at 5 knots speed	40 nautical miles.
Total fuel capacity	286.6 cubic feet.
Compressed air in reserve, at 2100 pounds pressure per square inch	13,773 cubic feet.
Number of air compressors	2
Number of centrifugal pumps (for water ballast)	2

Each pump can discharge 130 tons per hour at a depth of 130 feet.
Each pump is driven by a special motor.

I. SPEED.

The best French boats do not exceed a surface speed of 12 knots, and this applies to vessels of 400 tons.



THE ITALIAN SUBMERSIBLE "GLAUCO" UNDER WAY.

The British boats of 300 tons of the "C" class make only 13 knots. It will thus be seen that the Italian boats have accomplished a great deal more on a very moderate displacement.

II. RESERVE BUOYANCY.

The Italian boats, when running in light trim, have a reserve of buoyancy of 60 per cent of their displacement. The French underwater craft of the "Aigrette" type have about 20 per cent reserve buoyancy. The Lake type have 22 per cent, while the general run of the Holland boats have hardly 10 per cent.

Even when water is admitted to the superstructure, the Italian boats retain a reserve of buoyancy of 30 per cent. It will thus be seen how seaworthy these vessels should be, and what a large margin of safety they have against damage due to collision or any shock producing leaks.

III. STABILITY.

The Italian boats stand quite alone in the point of considerable metacentric height when submerged. As has been said, the metacentric height in that condition is nearly 12 inches. In the large English boats of 300 ton displacement, the metacentric height is only 9 inches, while in boats of the Lake type and "Protector" class it is only 7.2 inches. This gain in metacentric height adds very materially to the longitudinal stiffness of the Italian boats.

IV. SUBMERGED NAVIGATION.

The Italian boats can be submerged at once and on an even keel after a brief preparation in trimming from surface condition. The time required to adjust water ballast for this purpose is only five minutes, which has not been accomplished by any other submersible or submarine up to date. The boats retain a positive buoyancy, and submergence is effected by means of two special propellers which force the boats vertically downward. The various other submarine vessels in existence can be submerged only when under way if retaining a reserve of buoyancy. One would have to give these other vessels negative buoyancy if submergence on a level keel were desired. This would be a dangerous operation, as it would then be difficult to prevent the craft from sinking below the predetermined depth. The "Porpoise" sank in this manner and narrowly escaped destruction, and the "Octopus" did the same thing during her official acceptance trials, but fortunately the bottom was not so far away as in the case of the "Porpoise."

The Holland boats submerge when under way at an angle of 10 to 12 degrees until the desired depth has been reached. This depth, however, can only be maintained by the exercise of great care and skill on the part of the operator at the horizontal rudder. Therefore, submerged navigation in shallow water at high speed with boats of the diving type is a very dangerous operation.

The Italian boats run submerged with a change of longitudinal trim of not more than 1 to 2 degrees at the very most, and with a variance in vertical movement of less than 20 inches.

V. MOTIVE POWER.

The Italian boats are driven by three propellers. The middle screw serves for cruising purposes, while all three of them are in motion when running at full speed. For submerged navigation the side screws only are operated. When running at cruising speed, the central screw alone is used at full power. The motors can thus be used at all times to the best advantage.

By a simple adjustment of the magnetic field the electric motors used for submerged navigation can be so cut down in the number of their revolutions that they can be turned over efficiently at the modest rate of 25 per cent of their high speed, and that without diminishing the tension. Switches for the batteries are thus done away with.

The accumulators themselves are small and handy. The weight of one unit amounts to only about 250 pounds. Their removal in case of accident is therefore much facilitated. With the heavy cells carried by the Lake and Holland boats this operation is a most difficult one, because each cell weighs not less than 1,200 pounds. The battery is hermetically sealed, and the gases developed are expelled outboard by special means. Hence the danger of an explosion by reason of these gases, which has been proved fatally great in some other submarines, is accordingly greatly reduced in the case of the Italian boats.

The explosive motors are driven by benzine. Up to the present time this is the only fuel permitting the construction of light motors of sufficient power to produce high speed. The manner of stowing the benzine and arranging its feed to the motors is such that no annoying features have manifested themselves at any time since these vessels were put in active service.

VI. DIVISION BY MEANS OF BULKHEADS.

The interior of the Italian boats is divided into eight separate watertight compartments. In this feature the Italian boats are distinctly unique. This divisioning makes it possible to hermetically seal and divide the engine rooms from the remaining divisions, and by so doing preventing the heat and any possible gases from the engines spreading into the other parts of the boats when submerged. Submergence is not delayed until the engine space has cooled down. It is simply closed at once and allowed to take care of itself until the boats are ready to return to the surface and to resume there propulsion under engines.

Furthermore, the safety of the craft is considerably augmented by this system of subdivisioning. The serious accidents that befell the French and English submarines showed plainly the need of subdividing by means of water-tight bulkheads. During the last Italian maneuvers, the submarine boat "Squalo" continued to run submerged despite the fact that she carried more than a ton of water in her engine room, which had gained admission there by reason of a defective valve of the water jacket of the motors. The U. S. submarine "Shark" lost her reserve buoyancy through a leak in her engine exhaust valve and very narrowly escaped going to the bottom in 1904. In the case of the "Shark" only a few pounds of water thus leaked into the vessel, yet it was enough to imperil her.

VII. TORPEDO-FIRING TUBES.

The Italian boats carry two bow torpedo tubes with their forward ends so formed that they offer but very little resistance to the water. These torpedo tubes, which are capable of carrying 18-inch torpedoes, are so placed that they lie somewhat back and below the stem, so that they are safeguarded in case of a bow-on collision.

VIII. HULL.

The hulls of the Italian boats are not formed with the customary circular cross section with a superstructure. They are built upon a patented system, and in form are quite like the ordinary torpedo boat. Apart from giving the vessels easy lines for surface speed, this particular construction admits of a very convenient installation of the machinery. The extreme bow and stern ends of the vessels are high enough inside for a man to stand upright. Because of their special form it is possible to install in the Italian boats more powerful motors, larger accumulators, and bigger pumps than are possible upon the same displacement in submarine vessels having the usual spindle form of main hull.

Even though the Italian boats have not the circular cross section recognized as being that best capable of resisting high compression, still they are able to withstand safely a submergence of 150 feet if such be required.

IX. SIGHTING INSTRUMENT.

The Italian boats are equipped with two sighting instruments for submerged navigation. These instruments are of the Russo-Laurenti type, and possess a field of vision of 50 degrees. The portion extending above the surface has a diameter of about 3.5 inches. The instrument is so designed that the eyepiece gives a large image and does not require the observer to keep his eye constantly fixed thereon. In this way eye fatigue is avoided, and continual observation can be had without any of the tiring stress common to the general run of these instruments. The instruments are so arranged that they give normal vision and magnified vision, the latter being designed to enable the observer to distinguish distant objects and to read correctly visual signals.

THE WEATHERING OF COAL.*

By S. W. PARR and N. D. HAMILTON.

JUDGING from the opinions of practical engineers and scientists, the present methods of coal storage without doubt often result in much loss from fires of spontaneous origin and more or less loss by a deterioration in fuel value of the coal itself. The leading factors entering into the cause of these losses have been pointed out as being: (1) the kind of coal as to its volatile combustible contents; (2) the presence of occluded inflammable gases in the coal both before and after mining; (3) the presence of pyrites or other sulphur compounds; (4) the size of the coal; (5) the presence of moisture; (6) the temperature, and (7) the accessibility of oxygen to the coal.

From the evidence at hand there seems to be very little doubt that the coals of the lignitic, bituminous, and semi-bituminous character with their relatively high amounts of volatile combustible matter have a much greater tendency to weather than the anthracites where the volatile matter is low. There is considerable evidence that methane and other inflammable gases formed during the decomposition of vegetable matter which produces the coal are contained in the crevices of the coal as it lies in the earth, and are liberated both during and after mining. This exudation of inflammable gaseous matter may be a prime element in mine explosions, and its continuance after storage may be a large factor in the deterioration processes.

Opinions differ as to just what part sulphur compounds, the most important of which is pyrites, play in the deterioration of coal. Some assign the leading part in cases of spontaneous ignition to pyrites, while others think that its action in this connection is of only minor importance and that absorbed oxygen has most to do with this phenomenon. Observations on the effect of the air upon pyrites, however, seem to have pretty generally established the notion that pyritic oxidation tends to raise the temperature of the coal as well as to increase the tendency of the coal to break up, and that this oxidizing action is quite appreciably increased by the presence of moisture.

That slack is much more liable to spontaneous ignition and the deteriorating influence of weathering agents seems to be the general opinion. Having more surface the finer particles absorb oxygen much more rapidly and this rapidity of absorption causes an increase in temperature which in turn produces better conditions for absorption and chemical action between the carbon, hydrogen, and pyrites of the coal and the absorbed oxygen. It would seem that the finer coal would hold the moisture longer, resulting in a greater use being made of its catalytic qualities.

It is thought by some authorities that the only part moisture plays in the deterioration of coal is to materially assist the pyritic oxidation or by alternate freezing and thawing in the crevices of the coal to expose more surface to weathering agents. There are many, however, who believe that aside from increasing the oxidation of pyrites, water has to do with other chemical activities, which result in the decomposition of the coal. These believe that oxidation of the carbon and hydrogen of the coal is hastened by the action of the water present. This latter view seems to be based on the fact that moisture has seemingly, in some instances, greatly increased the deterioration of practically non-pyritic coal.

That an increase of temperature has much to do with increasing the activity of the other deteriorating agents is the general belief. This rise of temperature, whether coming from outside sources or physical or chemical action within the coal, tends to accelerate the absorption of oxygen and thereby increases the oxidation going on and also evaporates the gases which may still be occluded in the coal. Thus, heat assists in decreasing the fuel value of the coal and at the same time increases its liability to ignition. That the exclusion of oxygen from coal will decrease its loss in heating value is a growing belief.

From the evidence at hand, therefore, it would seem that not only do observers differ widely as to the causes and extent of weathering, but no very exact study of the problem has been made in all of its phases on which could be based very much either of theory or fact concerning the deterioration of coal in storage.

EXPERIMENTAL WORK.

In the present studies no attempt has been made to include all types of bituminous coals, but only those of the Illinois field.

There were nine initial samples taken of approximately 100 pounds, respectively. The coal was of small lump or nut size, and each sample was subdivided in order to subject the same kind of coal to various conditions. These conditions were to be continued through nine months, and in general were:

(a) Outdoor exposure; (b) exposure to a dry atmosphere at a somewhat elevated temperature, ranging between 85 deg. and 120 deg. F.; (c) under the same conditions as (b), so far as temperature was concerned, but to be drenched with water two or three times per week; (d) submerged in ordinary water at a temperature approximately 70 deg.

The periods for examination were divided as nearly as the work would permit into

1. The initial analysis of the fresh coal.
2. After exposure for five months.
3. After exposure for seven months.
4. After exposure for nine months.

SUMMARY OF RESULTS OBTAINED.

(a) Submerged coal does not lose appreciably in heat value.

(b) Outdoor exposure results in a loss of heating value varying from 2 to 10 per cent.

(c) Dry storage has no advantage over storage in the open, except with high sulphur coals, where the disintegrating effect of sulphur in the process of oxidation facilitates the escape of hydrocarbons or the oxidation of the same.

(d) In most cases the losses in storage appear to be practically complete at the end of five months. From the seventh to the ninth month, the loss is inappreciable.

(e) The results obtained in small samples are to be considered as an index of the changes affecting large masses in kind rather than in degree, but since the losses here shown are not beyond what seems to conform in a general way to the experience of users of coal from large storage heaps, it may not be without value as an indication of weathering effects in actual practice.

* From Bulletin No. 17, University of Illinois, Engineering Experiment Station.

MALLEABLE IRON CASTINGS.*

COMPARISON OF METHODS USED AND METHODS OF ANNEALING.

BY C. H. GALE.

MALLEABLE iron is melted in the reverberatory furnace, the open hearth furnace and the cupola. The reverberatory furnace is the most extensively used, about 85 per cent of the entire output of the United States being melted by this process. But little change has been made in this type of furnace since its adoption by the earlier manufacturers, beyond a marked increase in capacity. Prior to about 1885 the standard furnace was one of 5 tons capacity. This has been increased from time to time, until at the present time we have furnaces of 25 and 30 tons capacity, though furnaces of from 10 to 15 tons capacity are the most popular, and give more uniform results than those of larger capacity.

The adoption of the open hearth furnace for malleable iron dates back about 15 years. This type of furnace is now used largely and successfully in this district, more than 50 per cent of the malleable iron made by the open hearth furnace being produced in the Pittsburg district. This success, which has not always followed the introduction of this furnace in the malleable foundry, can be attributed to the local familiarity with this type of furnace from its extensive use in our steel mills.

THE SEVERAL TYPES OF FURNACE COMPARED.

The open hearth furnace has many advantages over the reverberatory furnace, especially where the output is large, and orders guarantee a long, steady run, the chief advantages being cost of repairs and period of operation. A run of 300 to 400 heats without the loss of a single day for repairs is not uncommon. Then will come a shutdown of a week's duration for minor repairs and cleaning out, putting the furnace in condition for another like run. This long, uninterrupted run, to the operator of the reverberatory furnace, when customers are calling for deliveries, and who at the most can get but a week of uninterrupted service, or 12 to 18 heats from his furnace, seems like the dawn of the millennium.

After 1,200 or more heats the open hearth furnace will need a general repair requiring four or five weeks, and here in the length of time required to make these repairs is where the reverberatory furnace has the advantage, it being a not uncommon practice during a busy season to rebuild the side walls, repair bridge walls and put in an entirely new bottom with the loss of one or at most two days' time. During a very busy season these repairs are frequently made on Sunday, thus avoiding the loss of a working day. Moreover, the reverberatory furnace can be charged within a few hours after these repairs are completed, while the open hearth furnace requires as many days to be brought to the required temperature before receiving the charge.

A heat of iron, after being melted and brought to the proper condition for casting, can be held in the open hearth furnace without injury for a much longer period than in the reverberatory furnace, not being subjected to the intense oxidizing flame of the latter, especially that produced by the use of the top blast.

Cupola melted iron does not possess the tensile strength nor ductility of iron melted in the reverberatory or open hearth furnace, due partly to the higher carbon and sulphur caused by the metal being in contact with the fuel. This feature is rather an advantage than otherwise, as most of the product of cupola melted iron consists of pipe fittings—castings that are not subjected to any great stress or shock. These castings are threaded, and a strong, tough malleable iron does not cut a clean, smooth thread, but rather will rough up under the cutting tool.

ANNEALING.

The annealing process for malleable castings differs from that of steel castings in that in the case of steel when recalescence, or the refining temperature has been safely reached, it is needless or rather unwise to prolong the heat, while in malleable iron the annealing process has at this period but begun. This heat must be maintained for from two to four days, depending upon the thickness of sections of the castings under treatment and the compactness with which the castings or annealing boxes are placed in the furnace. The annealing temperature, 1,550 to 1,600 deg. F., is, however, not absolutely essential to thoroughly anneal malleable iron. This can be accomplished at a temperature as low as 1,300 degrees, but the time required will be at least twice that of the higher temperature.

There are but few concerns engaged in the business for any considerable time with whom there has not been tried out the process of annealing without surrounding the castings with a packing material, but the heavy scale formed on the castings and their general unsightly appearance, together with a refusal of acceptance on the part of the customer, soon convinces the experimenter of the folly of continuing the process. Malleable castings can be annealed without the aid of any packing material and still preserve their appearance, and without the formation of scale by placing them in an airtight receptacle excluded from the flame and gases in the furnace; however, as economy of production is the objective point sought, this process has nothing to commend it.

MATERIAL USED FOR PACKING.

Until recent years the material in which castings were packed for annealing was composed of hammer and rolling mill scale, turnings, borings, etc. This was treated with a solution of sal-ammoniac or muriatic acid to form a heavy coating of oxide. This method has, however, been nearly superseded by the use of slag. The slag that is skimmed from the bath of the melting furnace, when ground to pea size and smaller in a tumbling barrel, makes an excellent packing material. Care should be taken to cool this slag with water as it is being skimmed from the melting furnace, it being the custom in some foundries to use old sand with which to deaden the heat. Better results can be obtained from this slag in the annealing furnace if kept quite free from sand and dirt.

Many malleable foundries in the vicinity of blast furnaces, where granulated slag can be had at a small cost, use this for annealing, it being probably the most economical. Fire sand and fire clay are also used, fire sand being an excellent material where the castings are very light and of intricate shape. Such castings, when packed in sand, will retain their shape, even though the furnace be overheated. This sand, however, deteriorates very rapidly if not renewed. Experiments conducted without the addition of new sand gave the following results: First and second times of using gave good, well annealed castings; third and fourth times of using gave castings with a fair anneal, but showed a tendency to weakness; fifth time showed a still weaker casting, while the sixth and seventh times the sand was used produced castings of but little more strength than the original hard iron, and they had to be returned for reannealing. After the seventh time of using the sand resembled a heavy wood ash.

The theory of oxidizing the scale and borings that was adhered to so long was that the castings would become decarbonized by the oxygen in the packing material combining with the carbon in the castings, the large percentage of iron oxide in the furnace slag, about 50 per cent, being the principle that first led to its substitution for scale and borings, but that the presence of a large percentage of this oxide is not essential is proved by the results obtained when annealing with materials containing little or no oxide. Many malleable foundries where scale and borings are still used have discontinued the oxidizing of this material with sal-ammoniac or acids.

PHYSICAL CHARACTERISTICS.

The physical characteristic that gives malleable iron its greatest value, and wherein it differs from gray iron, lies in its ability to resist shocks and an increased tensile strength. The degree of malleability in light and heavy castings varies. In a light casting ¼ inch thick and less, it means a soft, pliable condition and the ability to withstand considerable distortion without fracture, while in the heavy sections, ½ inch and over, it means the ability to resist shocks without bending or breaking.

The tensile strength of malleable iron varies with the thickness of the metal, the lighter sections having a greater strength per square inch than the heavier sections. This fact is now being recognized by engineers and at least one eastern railroad, which requires its malleable castings made in accordance with specifications, designates the tensile strength desired in its castings to be as follows: Sections ¾ inch thick or less should have a tensile strength of not less than 40,000 pounds per square inch; those of ⅞ to ¾ inch thick not less than 38,000 pounds per square inch, and those over ¾ inch not less than 36,000 pounds per square inch. In recent tests along these lines, test bars ⅝ and ¾ inch in diameter were made in the same mold and poured from the same ladle, thus insuring equality of metal, and annealed together. The average tensile strength of five pairs of bars so treated, representing five heats, was: ⅝-inch bars, 45,095 pounds per square inch; ¾-inch bars, 41,316 pounds per square inch. Average elongation in 6 inches: ⅝-inch bars, 5 3-10 per cent; ¾-inch bars, 4 2-10 per cent.

A very high tensile strength can be obtained approaching that of cast steel, but at the expense of the malleability of the product. The writer has seen malleable test bars having a tensile strength of between 60,000 and 70,000 pounds per square inch, but the ductility and ability to resist shocks of these bars were not equal to those of bars breaking at 40,000 to 45,000 pounds per square inch.

THE STRENGTH NOT IN THE SKIN.

It was formerly the general belief that the strength of malleable iron was largely in the white skin always found on this material, but it has frequently been demonstrated that the removal of the skin does not proportionately lessen the strength of the casting.

The process of annealing is one of conversion of carbon, there being practically no change in the other elements. The carbon in the original cast state is all in the combined form, this being converted by the heat treatment to graphite. This graphitic carbon, however, differs from that present in pig iron or gray iron castings, a difference that is readily noticed by the chemist. Instead of being present in crystals or grains distributed throughout the metal, it presents itself in an amorphous state, extending through the metal in minute filaments.

Besides the conversion of carbon, there is also a partial elimination of carbon, the loss being greatest in the white skin, the carbon content of which will vary from 0.10 to 0.20, while the interior of the casting will have a total carbon of about 2 per cent. The percentage of loss of carbon is, however, not constant, varying with the material with which the castings are packed for annealing. With a carbonaceous material, as coke, the carbon loss is less than with slag or scale, while castings annealed in coke have a higher sulphur content than before annealing, due to the absorption of this element from the coke.

The following analysis will give a good average of the changes in the elements during the annealing process, slag and coke being used:

	Si.	S.	P.	Mn.	C.C.	G.C.
Hard iron	0.63	0.043	0.147	0.21	2.54	Trace
Annealed in slag	0.61	0.049	0.145	0.21	0.24	1.65
Annealed in coke	0.61	0.065	0.150	0.21	0.25	2.00

The casting of direct malleable iron, thus eliminating the tedious and expensive annealing process, is a very alluring proposition to the manufacturer, but despite the best efforts of the founder and metallurgist it still remains an iridescent dream, holding in abeyance the fame and fortune of its discoverer until the solution of its fellow problem, the conversion of iron into gold.

* A paper read before the Pittsburg Foundrymen's Association.

THE IMPORTANCE OF NITROGEN IN CASE-HARDENING.

IN a paper read by Mr. G. Shaw Scott before the Iron and Steel Institute, some experimental data are recorded, showing the importance of nitrogen in the case-hardening process. A certain steel was selected which had been found specially suitable for case-hardening. This steel had the following composition: Carbon, 0.14; silicon, 0.01; sulphur, 0.08; phosphorus, 0.03; manganese, 0.58; iron (by difference), 99.16. Samples of this steel were case-hardened in small cast-iron boxes, being packed in a variety of materials such as burnt leather, wood charcoal, anthracite coal, sugar charcoal, potassium ferro-cyanide, potassium cyanide, petroleum, gas, bone, horn, graphite, bone black, acetylene, barium carbonate, coal gas, etc. It was demonstrated that there was no carbon penetration in bars heated for four hours at 700 deg. C. (1,292 deg. F.), and that a temperature of 800 deg. C. (1,472 deg. F.) was about the minimum temperature at which carbon penetration took place to an appreciable extent.

Samples treated for four hours at a temperature of 900 deg. C. (1,652 deg. F.) showed a carbon penetration of 0.063 inch. It was demonstrated that this temperature gave uniformly better results than higher temperatures. Barium carbonate and wood charcoal gave about two times as deep a carbon penetration in four hours as wood charcoal alone, and about one-third deeper penetration than burnt leather. But when the heat was sufficiently prolonged, the several mixtures gave approximately the same results. All the case-hardening materials in common use contain nitrogen in some form or other, or have the power of utilizing

atmospheric nitrogen, and it appears that nitrogen is the active element in promoting carbon penetration, although the free gas has no effect on steel itself. Ammonia, which is a prominent constituent of case-hardening materials, is the chief supplier of nitrogen, and experiments were made that showed that ammonia gas caused deep carbon penetration with materials that without its presence had only slight carburizing effect.

THE METROPOLITAN TUNNEL IN PARIS.

ITS CONSTRUCTION WITH THE AID OF THE PIFRE ERECTOR.

FOR the section of the Metropolitan railway, about two-thirds mile in length, which passes under the two arms of the Seine and the Ile de la Cité which they surround, a steel tube, lined and covered with concrete and cement, has been substituted for the masonry construction of the rest of the subway. This tube is composed of segments about 2 feet long, riveted together. It is lined with a layer of concrete which, in turn, is lined with pure Portland cement, and the voids between the tube and the surrounding earth are filled with cement mortar forced in under pressure.

Like the masonry subway, the steel tunnel is oval in section. It is about 25½ feet wide and 19¼ feet high in outside dimensions and 24 feet wide and 18 feet high inside the cement lining. Each of the short segments, or rings, of the steel tube is composed of twelve voussoir plates, 1½ inches thick and 6 feet in length measured along the arc of curvature, and a thirteenth voussoir, or keystone, 22½ inches in curved length. Each voussoir is surrounded by a perforated flange, cast in one piece with it and projecting from the concave face to a distance of 5 inches along the curved and 8 inches along the straight edges. This construction permits the plates to be assembled and riveted together from the interior of the tube. A thin layer of creosoted wood and tarred oakum is interposed between adjacent plates.

The under-river parts of the tube were made in sections mounted on caissons which were subsequently sunk to the desired depth. The assembling and riveting were done above the water level, in air of atmospheric pressure, and presented no special difficulties. The portions of the tunnel that lie below the water level near, though not directly beneath, the river are being constructed by the shield and compressed-air system, in which the assembling of the voussoirs by the usual hand methods would be an extremely tedious and costly, if not an impossible, operation. Indeed, for effective and economical employment of the compressed-air system it is necessary for the shield to be followed immediately by a machine by which the successive rings of the tube can be assembled as fast as the shield advances. Such a machine, the erector, was known, but it had been employed only in the construction of tunnels of circular section in which all the voussoir plates are alike and placed at equal distances from the axis. (The erector was first used in 1895, in building underground railway stations in London, and a little later in the construction of the Blackwall tunnel under the Thames.) In a tube of elliptical section in which the voussoirs are of different curvatures and unequally distant from the axis, the conditions under which they must be lifted and set in place may vary from plate to plate.

M. Abel Pifre has succeeded in overcoming these difficulties and constructing a machine which lifts each plate from the floor of the tunnel, raises it to its assigned place with marvelous accuracy and holds it there in the proper position while it is being riveted. This machine is now in operation in the heading under Rue Danton. It comprises two chief parts: a traveling platform which closely follows the shield and carries various accessory machines, and a balanced arm which can be lengthened, shortened, and turned about a horizontal arbor projecting forward from the platform and approximately coincident with the axis of the tunnel (Fig. 1). The moving platform (Fig. 2) is composed of three beams, two in front and one behind, fastened together by cross beams and supporting a floor of planks. The entire weight rests on two axles and four small wheels which roll on two rails supported by brackets, *B*, attached to the lateral voussoirs of the rings already completed. The deformation of these rings by the weight of the loaded platform is prevented by the tie rods, *L*, which connect the brackets on opposite sides of each ring. The platform is moved by a hand capstan, *C*, which drives the axles by means of wheel and chain gearing. The rotating arm is composed of two parts, one of which telescopes within the other. One end of the outer or fixed arm is rigidly and very strongly attached to the end *E* of the horizontal arbor *A*, while the other end bears a

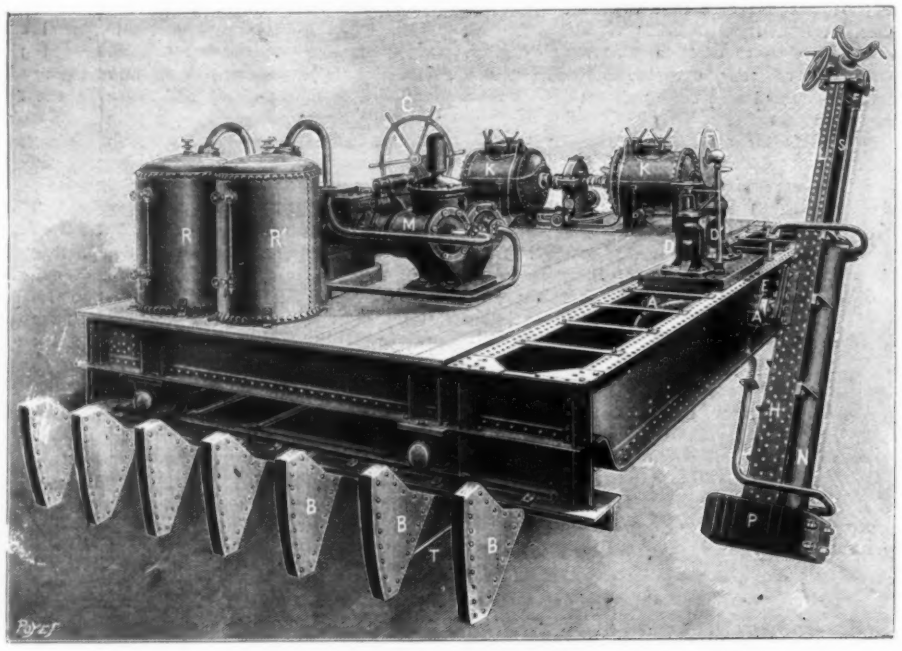


FIG. 2.—THE PIFRE ERECTOR.

H. Fixed arm. L. Sliding arm. N. Radial press. S. Piston rod. E. Head of horizontal shaft A. P. Counterpoise. B, B. Brackets. T. Tie rod. C. Capstan. M. Pump. R, R'. Reservoirs. D, D'. Distributers. K. Mortar pump.

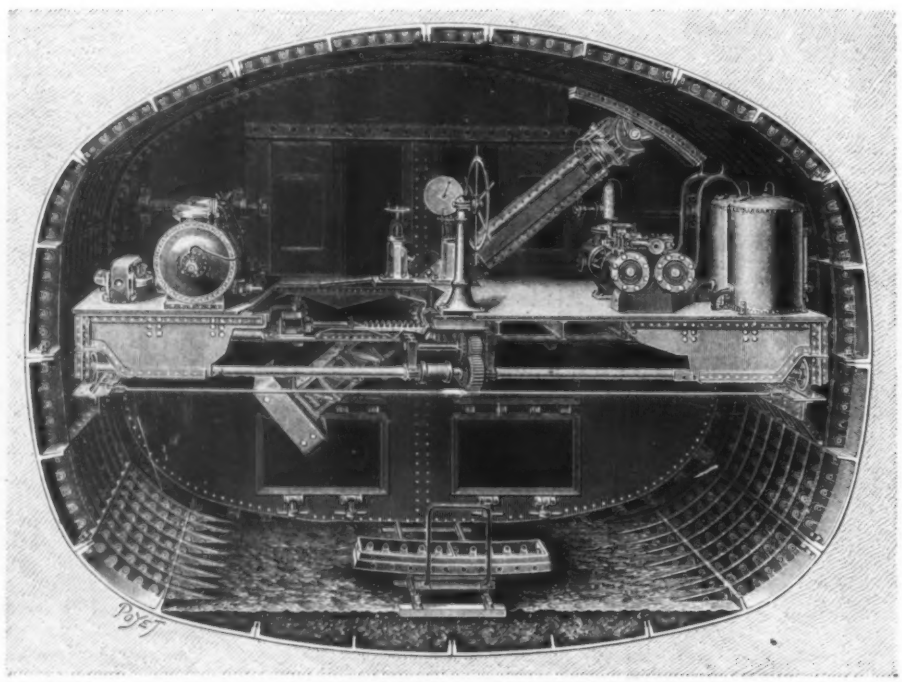


FIG. 1.—THE PIFRE ERECTOR IN OPERATION.

counterpoise *P* (Figs. 2 and 4). The inner or sliding arm, *L*, terminates in an ingeniously constructed head, or "grip," furnished with four clamps which are adapted for seizing the longitudinal flanges of the voussoirs, which are always 2 feet apart (*D D'*, Fig. 3-I).

The radius of the circle described by the counterpoise is about 7 feet, while that of the arc described by the grip varies from 6¼ feet for the top and bottom to 12½ feet for the lateral voussoirs.

To the front of the fixed arm is attached a hydraulic press, called the radial press (*N*, Fig. 2), of which the piston rod *S* is equal in length to the sliding arm. The heads of the rod and the sliding arm are fastened together and thus the arm can be extended and retracted by operating the radial press.

The horizontal shaft *A* of the rotating pair of arms bears a pinion which engages with a rack *F* (Fig. 4), the ends of which are attached to the pistons of powerful horizontal hydraulic presses, *P* and *P P*, placed on the right and left sides of the platform. When these presses, which are controlled by the cylindrical distributer *D* (Fig. 2) are operated simultaneously in the proper directions they work together to move the rack and turn the arms. The radial press is controlled by a similar distributer, *D'*.

In order to set the voussoirs with perfect accuracy, the grip of the sliding arm is made capable of movements of various kinds. This flexibility is also useful in taking up the voussoirs from the trucks which bring them to the work. The grip is caused to rotate about the longitudinal axis *E* (Fig. 3-I) by turning the wheel *V* which drives a tangent screw engaging with the toothed wheel *R* on the arbor *M*. Thus the plate can be seized in any position in which it may be presented and then brought accurately into the vertical plane of the ring for which it is destined.

The four clamps of the grip are mounted in pairs on the ends of the transverse shaft *T*. One clamp, *C* or *C'*, of each pair is rigidly attached to the shaft and is controlled by the wheel *P*, by means of the screw *A* and the toothed sector *B*. The other clamp, *H*, of each pair is free. Each voussoir plate, in addition to its peripheral flange, has a longitudinal rib *U* and a transverse rib *U* which intersect at the center of the plate. The clamps, however, are attached to the longitudinal flanges *D* and *D'*, one pair to each, and the clamps of each pair are bolted, by means of the pins *F*, to two rivet holes, *K*, equidistant from the cross rib *U* (Fig.

3-I, II). Owing to the differences in the curvature of the plates the angle, α, between the arms of the clamps is not the same for each plate. The fixed clamps C and G are therefore turned by the wheel P until they find their rivet holes, after which the loose clamps H are easily fitted to holes symmetrically placed on the opposite side of the central cross rib C.

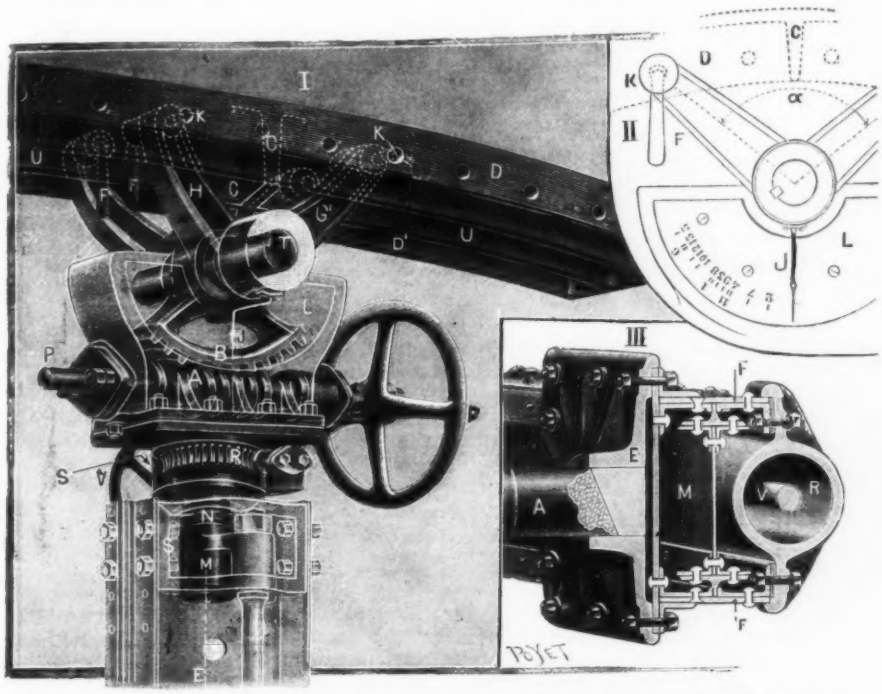


FIG. 3.—I. DETAIL OF HEAD OR GRIP. II. DIAL INDICATING INCLINATION OF GRIP FOR EACH OF THE 13 VOUSSOIRS. III. TRANSVERSE SECTION OF ARMS.

A. Shaft. K. Head of shaft. F. Fixed arm. M. Sliding arm. R. Radial hydraulic press. V. Piston rod of press.

The angle of position β (Fig. 4), which marks the amount by which the axis of the grip must deviate from the arm in order to set the voussoir properly, varies according to the part of the ellipse which the voussoir is to occupy. After the plate has been locked in the grip by inserting the pins, this angle is fixed by turning the wheel P (and consequently the clamps and plate) until a needle J, attached to the fixed clamp C, coincides with a particular radius of the dial L (Figs. 3-I, II), which is inscribed with thirteen radii, numbered to correspond with the thirteen voussoirs of the ring.

The operation of the Pifre erector is very simple. A truck carrying a voussoir plate is pushed forward under the platform and the rotating arms, which are set vertical with the grip downward, and the sliding arm retracted. The arm is then extended sufficiently to enable the clamps of the grip to be bolted to the flanges of the plate as it lies on the truck. This done and the truck removed, the angle of position β, which determines the inclination of the center of that plate to its radius vector, is adjusted in the manner described above. Then the operator on the platform starts the distributer D of the horizontal presses, causing the arm which carries the plate to revolve until its axis coincides with the proper one of thirteen numbered radii inscribed on the disk F, which faces the operator. This operation is performed in a few seconds. The distributer D' of the radial press is next started, causing the arm to elongate and carry the plate to a position slightly in advance of its proper place, and the setting of the plate is completed by a slight backward movement of the arm. As the moment of the weight of the plate varies with the length of the sliding arm, and as the arm is not loaded during the entire operation, the counterpoise is adjusted to balance half the weight of a plate at the mean distance from the axis.

After one straight flange of the plate has been riveted to the flange of the preceding plate of the ring under construction and one curved flange has been riveted to the flange of the corresponding plate of the completed ring just behind, the grip is unlocked and the arm, now unloaded, is shortened and turned into a vertical position by the hydraulic presses for the purpose of taking the next voussoir from its truck below.

The bottom plates of the ring are first set and plates are added alternately on each side until the small key voussoir at the top is reached. The shield advances 4 feet in twenty-four hours and no difficulty is experienced in assembling and riveting in the same period of time the two rings of plates which occupy that space.

The platform (Fig. 2) carries a Worthington pump, M, operated by compressed air, which forces water at a pressure of 114 pounds per square inch into the reservoir R, which feeds the hydraulic presses. The water discharged from the presses is collected in the reservoir R' for future use. The apparatus is completed by a mortar pump, K, which forces cement mortar at a pressure of 43 pounds per square inch through holes made in the plates for that purpose until all voids existing between the tube and the surrounding earth are completely filled. This external coat of cement absolutely prevents infiltration of water and rusting of the tube.

Some trouble has been occasioned by deformation of the tube during construction. Owing to the pressure or the softness of the soil or the weakness of the flanges and ribs, the elliptical section tends to elongate and flatten, leaving insufficient room for the key voussoir. Such deformation is common in soft mud and quicksand. In the construction of the recently completed Pennsylvania Railroad tunnel under the Hudson it was found necessary to introduce temporary tie rods along the horizontal diameter of the circular section in order to prevent spreading. Such a precaution should be still more essential in an elliptical tube, and it will probably have to be adopted even in the Paris tunnel, where the nature of the soil appeared to make it unnecessary.—E. de Loyselles in La Nature.

PHOTOGRAPHY IN CONSTANTINOPLE.

THE bulletin of the French Chamber of Commerce in Constantinople contains the following report on the trade in photographic apparatus and supplies in Constantinople, reproduced in the Moniteur Officiel du Commerce and translated by the Bureau of Manufactures:

The natural conditions in this country are very favorable for photography. The light is magnificent and the sky splendid. In Egypt special precautions must be taken on account of the excessive heat, which sometimes causes the gelatin to melt; in Turkey there is nothing to fear on that score.

The number of photographers has increased enormously. Thirty years ago there were only three or four at Pera; at present they are too numerous to count and are found everywhere—at Pera, Galata, Stamboul and the suburbs. There is naturally very keen competition among them, and as a consequence they are compelled to give preference to the apparatus and supplies sold at the lowest prices.

The number of amateurs, which was negligible in the past, has increased considerably during the last eight or ten years. Almost everybody is taking pictures. The Mohammedans, who were greatly opposed to this diversion up to a few years ago, have now taken it up seriously, and some photographers of real merit are found among them. And finally the tourists who come to Turkey are all equipped with photographic apparatus.

During the last year, however, the trade in photographic supplies has been perceptibly slow. Is it due to competition and the increased number of dealers? Persons familiar with the situation are inclined to attribute this falling off in the trade to the increased cost of living. Photography involves considerable expense for amateurs, who are therefore not apt to indulge too freely in that pastime. Besides, the number of serious amateurs at Constantinople is rather small. Many of them have their films developed by professional photographers, as is evident from the large sale of photographic paper in large sheets, which are bought only by professional photographers, who effect a saving in cutting them into small sizes.

Still, in spite of all these drawbacks, the sale of photographic apparatus and supplies in this city is of considerable importance. It is not believed, however, that it is ever going to attain a very large sum, in view of the fact that the articles involved are of comparatively small value.

GERMANS PROFIT BY ADVERTISING.

Apparatus.—The apparatus used by the professional photographers are equipped with German lenses. The Germans advertise enormously, advertisements of their apparatus being found in almost every paper. This is one of the causes of their success.

Amateurs use hand cameras or kodaks, which up to a short time ago were intended only for films, but which are now made both for films and plates. But, as said before, the number of amateurs is rather limited. The majority of them are in search of cheap apparatus, and as a result the German cameras so well advertised are in greatest demand. German manufacturers produce apparatus at prices which defy competition, as low as 6 francs ($1.16) each.

Films.—Films come in rolls of a dozen exposures each; double rolls, or those of six exposures, are not in demand. The objection the dealers have to the films is that they are dated, the date indicating the period for which they are guaranteed by the manufacturer. This makes it impossible for the dealers to sell films whose guaranty period is near expiration, and consequently the retailers cannot carry large stocks. In view of the large number of kodaks in use and the time required for a voyage from Paris to Constantinople, it is evident that the dealers would run a considerable risk in carrying a complete assortment of films.

Plates.—These are furnished almost entirely by France. They come in boxes of 12, and 6 for the

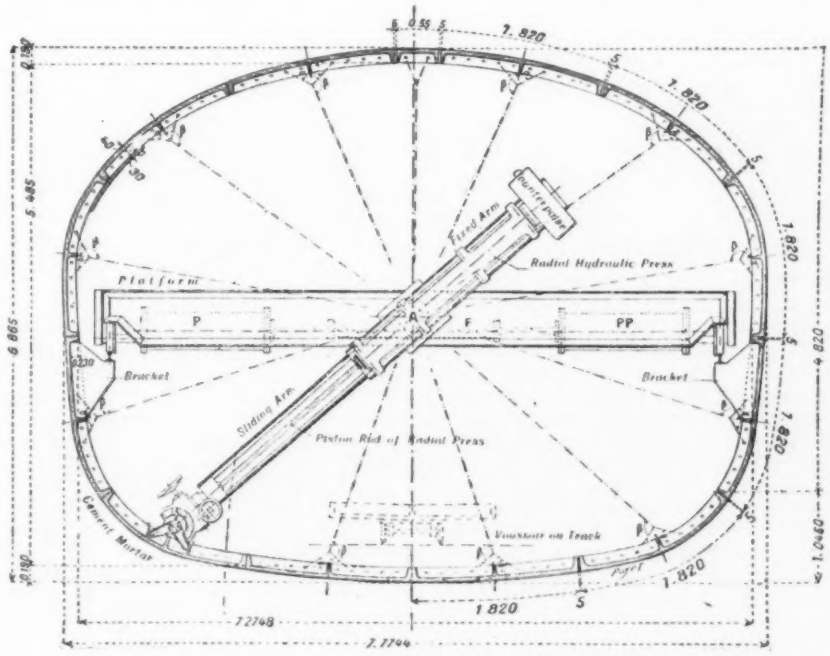


FIG. 4.—DIAGRAM OF THE PIFRE ERECTOR.

larger sizes. The sale of French plates could be greatly increased by reducing the price and affording greater facilities to the dealers.

Some German manufacturers have introduced a plate bearing an American flag and sold as of American origin. These plates are bought to some extent by the professional photographers on account of their low price. Other German plates, sold as such, also find some buyers.

Sensitized Paper.—This article is also imported almost entirely from France, being furnished by the same houses that furnish the plates. Paper is sold in packages of 6 and 12 sheets, and is divided between nitrate and bromide papers. The former has the larger sale, but the latter is coming more into fashion.

FRANCE AND GERMANY FURNISH SUPPLIES.

Accessories.—The numerous accessories, such as lamps, trays, printing frames, drying racks, etc., come from Paris and Germany.

Chemicals.—The most used are hyposulphite of sodium, bromide of potassium, carbonates of sodium and potassium, some acids, etc. While in the case of most chemicals it is impossible to compete with the low prices of the German chemicals, some chemicals are imported from Paris and Lyons. Developing and fixing solutions, which are so important in photography, are mostly prepared here from imported chemicals, but some of them are imported from Europe, amateurs having more confidence in European brands. These come from Paris and Germany. Chloride of gold comes from Paris; the importation of magnesium is prohibited.

Cardboard.—Photographers' cardboard, passe partout, and other cardboard products are imported largely from Vienna, where the conditions for their manufacture are most favorable, and to some extent from Berlin.

Dealers.—There are four large houses dealing in photographic apparatus and supplies in Constantinople (three at Pera and one at Stamboul), one of them being a French house. Some small merchants also carry photographic supplies.

Packing.—In the case of articles of so delicate a nature, where packages can not be opened to ascertain partial damage, careful packing is very essential. Firms shipping in large and heavy boxes seem to invite disaster, as the porters here are very rough in their handling of boxes, especially if they are very heavy, even when they bear the inscription "fragile." On this account small, light, and well-packed cases are necessary.

Terms.—No firm charges for packing. The Germans sell f. o. b. Constantinople, on six months' credit. They also extend other facilities to their customers. These are the best means to keep customers, and French firms are urged to extend the same facilities. To resume, it may be said that France occupies a good position in this trade in Constantinople, but its sales could be greatly enlarged.

RECOVERY OF GOLD AND SILVER RESIDUES.

SOME PRACTICAL SUGGESTIONS.

BY DR. THEODOR KOLLER.

RECOVERY OF GOLD FROM FLUIDS CONTAINING GOLD.

BOETTGER brings the fluids to a boil in porcelain vessels, adds to them then a solution of sodio-protoxide of tin and keeps boiling until all the gold—in combination with tin—has been separated in the form of a fine, intensely black precipitate. This is washed out somewhat and dissolved in aqua regia; if this solution is carefully evaporated down, diluted with distilled water and to it a sufficient quantity of potassio-sodic tartrate (the so-called seignette salt) added and the whole heated, every trace of gold will be separated in the form of a very delicate brownish powder, the tin remaining dissolved.

RECOVERY OF GOLD FROM ELECTROPLATING BATHS.

According to Plage, a porous clay cell, filled with salt water, is placed in the gold solution, inside the cell a zinc slab is disposed and this is connected, by means of a brass wire, with a thin brass plate, immersed in the gold solution. After three to four weeks, with one or two renewals of the brass plate and cleaning of the zinc slab, the gold will be completely deposited on the plates; the latter are dissolved in nitric acid in a porcelain dish. The gold is washed out, dried, and it can subsequently be remelted with saltpeter in a Hessian crucible.

RECOVERY OF GOLD FROM OLD PHOTOGRAPHIC TONING BATHS.

F. Hough filters the old gold baths into a white glass flask, supersaturates the fluid with carbonate of soda, adding, drop by drop, an alcoholic solution of aniline red, until the fluid assumes a raspberry red color. If the flask be now placed in a brightly lighted window, the gold will be completely precipitated in six to eight hours, so that the fluid can be poured off. When, by repetition of this process, a sufficient quantity of this deposit has been gradually recovered, it must be well washed, placed on a filter and after the incineration of the latter, dissolved in a surplus of aqua regia. By evaporating the solution we obtain chloride of gold that can be used at once for photographic purposes again.

The processes of photography use a considerable quantity of gold and silver, the greater part of which goes to waste. At the present price of silver its recovery is not always economically possible. Julius Kruger has published full directions for the recovery of these metals, and we translate some of his instructions.

OLD SILVER BATHS.

The silver bath used by process workers finally contains silver in a mixed form, and especially in the double combination silver-iodine-saltpeter, that is, iodide of silver with nitrate of silver $= AgNO_3 + AgI$, which makes the recovering process difficult. The most extensively practised method of separating all the silver salts in such a bath as above described consists in adding common salt or hydrochloric acid, as long as a precipitate is formed; the silver is thereby precipitated in the form of chloride of silver. This is successful under all circumstances, but the chloride of silver thus obtained is more difficult to reduce and fuse than another silver salt, I mean carbonate of silver. If in place of salt, we take pure soda—carbonate of soda—to precipitate the silver, we obtain carbonate of silver, which possesses several advantages for reduction; notably it settles better and is more readily and easily reduced, and in melting does not foam up like chloride of silver. With the soda solution, we proceed in exactly the same manner as with the salt solution, stirring it thoroughly, letting it clear and continuing to add to it as long as a precipitate occurs. The carbonate of silver thus obtained appears as a light yellow, readily reducible powder, and in melting requires only a small addition of carbonate of sodium as a flux, in order to produce quickly a pure regulus.

THE DEVELOPING AND INTENSIFYING FLUIDS.

According to whether for these operations, sulphate of iron (green vitriol) alone or this and pyrogallic acid are employed, these fluids appear to be more or less dark colored and the precipitate formed in them is also of varying purity. It consists mainly of reduced silver, which appears more or less light according to its purity and when collected, washed, and dried, requires only to be melted with a little soda to yield chemically pure silver in a solid lump.

To recover the silver from old hypo fixing baths take a large wooden cask in which all old soda baths can be collected. Bore a series of auger holes, evenly 2 inches apart and extending in a vertical line, from the upper opening down to close above the bottom, and fit all with good tight stoppers. In this cask place a broad, bright strip of zinc, wound about with moderately thick copper wire and so long as to project somewhat above the fluid. When this apparatus has remained for some time in the fluid the latter will become entirely colorless, while the metal surfaces are covered with a gray metallic dust that can easily be knocked and wiped off. It consists of reduced silver, which in part subsides to the bottom and partly adheres to the zinc and copper and maintains exact proportions to the metal in solution. Of course this silver deposit is never chemically pure, rather it always contains zinc and copper, but this, in the subsequent smelting process, presents no difficulty. The addition of sulphate of iron (green vitriol) is not ineffective, but the silver precipitate so obtained is colored a deep black, due to sulphur as well as iron sulphide. Sulphate of copper or blue vitriol behaves in the same way.

SOLID ARGENTIFEROUS WASTES.

To obviate the bulkiness of papers, they are first burnt, in connection with which process it is advantageous to scatter dry saltpeter powder over the smoldering or glowing mass, whereby a slight decrepitation is caused. It happens in some cases that the silver is obtained in the form of exceedingly fine, small metallic globules. This, however, is not by any means the object; by reduction in volume a saving in space occupied is sought and at the same time, in expense and trouble, and these ashes can, without further ceremony, be mixed with the silver precipitates obtained from the different fluids, for melting down. This brings us to the second part of our task—the melting down or melting out of the silver. To what extent it is advisable to recommend to the photographer to carry out this process himself is doubtful, but many believe it possible to undertake the fusing in an ordinary iron stove and even claim to have obtained thereby the best results. The object sought in this tedious and dangerous work, however, is not the obtaining of some silver, but the obtaining of all the silver present in regulus form and with the least possible loss.

REFINING THE SILVER.

The silver being collected in any form, it must first of all be perfectly dried, either by spreading it out exposed to the air, or by artificial heat. This must be done thoroughly, for if the residue is still damp, and is transferred to a heated crucible, the latter will probably crack. In every melting there are two objects in view—complete reduction of the metal treated and the obtaining of the pure regulus in one piece. For this reason a so-called flux is necessary. This flux consists almost universally of an alkaline salt, a carbonate, also nitrate and chlorate, i.e., such a combination as will at the same time split up the silver combination to be reduced, and itself readily assume a fluid form, thereby contributing to insure the separation and falling in regulus form of the silver globules to the bottom, where it can collect. If we have to do with pure silver masses such as are obtained from development and intensification, the melting process proceeds exactly and quickly, whereas chlorate of silver, and to a still greater extent sulphide of silver, greatly impedes it.

However little the wastes resulting from photographic operations may be alike in chemical character, the fluxes are also by no means similar in nature; we have primarily the following salts for this purpose: carbonates of potassium and sodium, common salt or bi-borate of sodium, and so-called black flux, a mixture of caustic potash, carbonate of potash, tartrate of potash, sodium, and organic carbon. In their effects on the metal to be reduced, these salts are sharply characterized. The carbonic alkalies have a reducing effect and are also excellent fluxes, while chlorine, bromine, sulphur, etc., are taken up by them, carbonic acid being set free, the corresponding potassium and sodium salts are formed, which subsequently become a ready flux, which dissolves accidental impurities, like iron, copper, lead, also lime salts, and separate perfectly purified silver. They are most used, and as it is desired to unite the advantages of the potash salts with those of sodium, which is more readily obtained, being produced easily in the form of a dry powder, whereas the potassium salts readily liquefy, both are often mixed together, two parts of carbonate of sodium with three parts of carbonate of potassium, intimately rubbed down together. The nitric alkalies have an oxidizing effect on the base metals present and contribute to the perfect combustion of organic carbon constituents. Both are used for the refinement of precious metals and small quantities are added to the carbonates in order to obtain gold and silver of greater purity. Borax has the same effect as the last-named, not by oxidation, but because it forms a so-called glass flux with most of the base metals, i.e., dissolves them so that they are completely transformed into glassy slag. It is therefore likewise excellent for refining and in addition very valuable in that being an excellent flux, it brings the slag speedily into a fluid condition, whereby the separation of the precious metals is greatly facilitated. Borax is usually employed toward the end of the smelting process, not only to promote the greater purity of the gold and silver, but also to promote their conflux. Common salt, so highly esteemed by many practical men, operates only through its ready fusibility. We must, however, not expect common salt to reduce chloride of silver; it rather serves only as a flux, to promote the fusing together of pure silver particles, to which purpose it is especially well adapted. Under the title "black flux" a preparation is recognized which in the past has been employed almost exclusively for the

melting of the precious metals. As already stated, it consists principally of carbonate of potash and organic carbon, and is obtained by mixing two parts of bitartrate of potassium and one part of saltpeter together and igniting the mixture with the aid of a red-hot coal. With profuse smoke and fumes, a slow decrepitation takes place, and finally, when the mass is completely burned and cooled, there remains a black, carboniferous substance, the black flux. This salt mass is pulverized while warm and placed at once in tightly closed glass bottles to protect it from becoming moist, to which, owing to its property of attracting moisture from the air, it is very liable.

We now come to the charging or filling of the crucibles. Crucibles are cylindrical, conical vessels, made of fireproof clay. In spite of their durability in fire, these crucibles require a certain amount of care, for they may be affected by the substances which are melted in them. This applies, for instance, to those chemical substances that are capable of reducing quartz, such as silicic acid, and uniting with it to form silicates. In this case, it may happen that the walls or the bottom of the crucible may become perforated, so that the contents, if liquid, may drip or run out. Among these bodies we may include free alkalies, free bases, and such metals as form glass with silicic acid, oxide of lead for instance. In crucibles in which this is to be melted, an addition of chamothe, i.e., finely crushed fireproof pottery (sagger) fragments, is preferred in place of the quartz usually employed.

The charging or filling of the crucibles is effected as follows: The silver ashes, residues of the developing process and the salt precipitated as carbonate of silver, are intimately mixed, dust-dry, with the flux, which, for this purpose, consists of carbonate of potassium three parts, carbonate of sodium, one part. When after exposure to heat for half an hour, the fusing point is near, one part of niter (saltpeter) is added. Silver ash and flux are used in equal quantities by weight. The crucible at the commencement must be at most two-thirds full. It is well to cover the contents of the crucible with a thin stratum of common salt. If pure silver salt residue without ash constituents is to be melted, a mixture of equal parts of common salt and potash will suffice. When the mass fuses a very little dry powdered saltpeter may be added. Old collodion films, varnished or unvarnished, before and after fixation contain iodide and bromide of silver and are less easy of reduction, nevertheless a mixture of carbonate of potassium four parts, carbonate of sodium one part, and common salt one part, mixed with them in equal parts by weight, will speedily effect the desired purpose, if a quick, even fire is kept up.

Sulphide of silver is the most difficult to reduce, but this can also be easily effected if we treat it with equal parts of the following mixture: Carbonate of potassium, two parts; carbonate of sodium, three parts; common salt, one part, and iron filings, half a part. A very excellent medium for the reduction of sulphate of silver is cyanide of potassium, of which we require equal parts by weight. This result is the production of sulpho-cyanide of potash and the silver is separated in a chemically pure condition.

Chloride of silver, which I avoid wherever possible, can be reduced according to the method quoted for collodion films, it being advisable to use common salt alone for spreading over the crucible.

In all these mixtures care must be taken to have the different constituents absolutely dry and the crucible at most only three-fourths full to start with.

The crucible being charged, can be placed in a smelting furnace.

First place on the iron grate a piece of roof tile of the diameter of the crucible, not larger, so that the draft may not be obstructed unnecessarily. The crucible is now placed on it in the furnace, surrounded with wood and the latter ignited. As soon as it is burning vigorously cover it and the crucible with charcoal and coke and take care that the fuel is always heaped close about the crucible and covers it. For the regulation of the fire, a long iron poker is employed. All firing material or fuel must be dry, the crucible always closely surrounded and covered on all sides. If the first charge of the crucible is completely fused, we take small portions of the residue, wrap them in leaves of paper, make them into a ball and introduce it into the liquid mass. A slight foaming up follows and within a short time the contents of the crucible are again evenly fused. The addition of small quantities is repeated in the same manner until it is all filled in. Boiling over, with proper care and attention is not to be feared; if, however, the mass rises threateningly it can be stirred with a cold stirring iron, upon which it will at once fall back. After the last portion has been added, the fire is brought up to its greatest heat, actively tended, fresh fuel put on, and every effort made to quickly attain the greatest heat. This can be accomplished in half an hour.

When the reduction is considered complete the molten and liquid mass in the crucible may be tested first by its appearance (it must be perfectly white hot and evenly fluid) as well as with the aid of an iron wire, with which sample is drawn by dipping it into the molten mass. The wire will be covered with "slag," which can be examined with the help of a lens, to see if it still contains small separate silver globules. The slag must also present a clear appearance, neither rough nor sandy, which is a sign that it was not so perfectly fused as to allow these impurities to settle. If the sample drawn indicates the existence of any defect, and especially that silver has not been perfectly separated and combined into a regulus, the fire must be renewed and thorough fusing pursued again for a time, until a new sample gives the desired proof of complete reduction and of the collection of the silver. This result sometimes presents difficulties, especially when the smelting furnace lacks the proper draft or the accessory arrangements (dampers) are lacking, for outside of adequate fuel, the necessary heat can only be assured by a lively draft.

If this process is finally completed, the crucible is removed from the furnace with the aid of the tongs and placed on a brick, that has been previously heated. The silver can be taken out by pouring out or by cooling.

In pouring out an iron vessel, a mortar, etc., is used. It is greased well with tallow and the liquid silver ore and slag poured in slowly, after which, when thoroughly cooled, it can be knocked out and freed from all impurities.

If the crucible is allowed to cool slowly the silver regulus will settle completely; the cold crucible is broken up and the siver obtained in a solid, rounded, compact piece, free from slag.

An attentive worker, by closely following the foregoing instructions, will be able to obtain a satisfactory result, nevertheless a certain amount of practice and the insight gained therefrom are very desirable. Thus the beginner should never discard the slag without having previously tested it for silver. This is effected partly with the aid of a lens and partly and more certainly by dissolving a small sample in hydrochloric acid, which, as is well known, will not attack metallic silver. If the slag is found to be still impregnated with silver it must be re-smelted at higher temperature.

RECOVERY AND SMELTING OF GOLD.

All fluids containing gold should be poured together and in the event of their showing alkaline reaction, weakly acidified with some crude hydrochloric acid. A possible precipitate may be ignored and to the acid fluid a strong solution of green vitriol added, as long as this causes a precipitate; an excess will do no harm, but the fluid must not be very acid. After a short time a black precipitate of separated, reduced gold will be thrown down, which can be immediately filtered out. This precipitate can be allowed to settle of itself so that only the final residue, when everything has been poured off clear, remains to be filtered. Everything remaining on the filter is well washed out by pouring clean water over it several times, then dried. This being accomplished, the filter is burned over an open flame, the ash and its contents collected and both mixed in a porcelain mortar, with twice the quantity by weight of pure carbonate of sodium, perfectly dry and consequently crumbled down by exposure to the air, bringing the mixture at once into a sufficiently large crucible.

This crucible must be of a capacity twice as great as the salt volume and is to be covered with a second crucible that fits into it, the joining being sealed with good clay.

Thus prepared, the whole is placed in the fire, resting immediately on a small brick, then enveloped in charcoal, and as soon as this is thoroughly ignited the entire apparatus must be covered with charcoal and an intense, white heat maintained. After about two hours of firing the process is concluded; the fire is removed, the crucible allowed to cool gradually and then opened, the gold regulus being found at the bottom.

This is the simplest and most certain method and possesses moreover the advantages that in the event of a possible foaming or bubbling up of the molten mass, no trace of the metal can be lost.

For the melting out of silver wastes this little contrivance is also to be recommended.—Abstracted from "Handbuch der Verwertung, etc., von Abfallstoffen Aller Art."

ALCOHOL FROM PEAT.

WRITING from Mannheim, Consul Samuel H. Shank says that the large deposits of peat in America which have hitherto been of practically no value may prove to be of great worth if the recent experiments of a French chemist in distilling alcohol from peat prove to be practical, as now seems probable. He gives the following information upon the progress made:

The first industrial trials for manufacturing alcohol from peat date from the year 1870, when the Danish chemist Zetterlund hydrated and converted by means of sulphuric acid the cellulose of the peat into a soluble carbohydrate, which was fermented by letting it stand. The very small production obtained in the beginning was increased by different chemists, including Lagerheim, Trestadius, and Eckardsström.

Important progress has been made in the last two years by Raynaud, by fermenting the carbohydrate sap by means of a special yeast, which has hitherto been kept secret. A Copenhagen company has been founded, which already has two experimental plants established, one in Denmark and the other in France. The results obtained are said to be so encouraging that the erection of an industrial plant in the north of Germany is imminent. According to statements made by Prof. Ramsay, one ton of dry peat is said to furnish about 162 liters (liter = 1.05 quarts) pure spirits and about 66 pounds of sulphate of ammonia of 100 per cent.

The Danish company asserts that the manufacturing costs of 1 liter of alcohol of 97 per cent are at most 11 pfennigs (2.6 cents), whereas the cost of the process of distilling from potatoes is about 38 to 42 pfennigs (9 to 10 cents). It is self-evident that such a process would be of the greatest interest, not only from an agricultural standpoint, but especially for new uses in the chemical industry and as a cheap material for lighting and power.

THE SMOKELESS BURNING OF COAL IN BOILER PLANTS.

IN a preliminary report on the "Burning of Coal without Smoke in Boiler Plants," prepared by D. T. Randall for the United States Geological Survey, the results of an elaborate investigation to determine the best method of utilizing the coals of the United States are published. The following is a summary of the report:

The increasing use of gas and coke for domestic, manufacturing, and power purposes and the centralization of power and heating plants tend to relieve cities of a large percentage of the smoke now given off by small and inefficient heating and power plants. Notwithstanding the fact that other ways of utilizing coal are growing in favor, it will be necessary to burn coal in small boiler plants for some time to come. These coal-burning plants will continue to keep the problem of smoke abatement before the residents of large cities.

It is recommended that in order to improve the conditions in any city a record of all equipment and furnaces in the power plants be made, and that improvements, methods of operation, and the kinds of coal used be made a special study. It is only by such systematic methods that the local problem can be solved, as conditions in any one city are generally different from those in others, depending on the amount and kind of manufacturing and the character of the coal available.

The personal element is the most difficult obstacle to overcome in the fight against smoke. Study of the requirements and a desire to obtain good results on the part of the firemen will do more to clear the air in cities than any other one influence.

Being principally the result of an imperfect air supply, smoke can be prevented by providing for sufficient air and for its mixture with the gases in the furnace.

Well-designed furnaces may smoke to a greater or less degree, depending on the methods of the firemen, the kind or size of the coal, and the rate at which the coal is burned. They may be expected to give smokeless combustion when burning a suitable coal, except under the following unfavorable operating conditions:

1. When fires are built. The furnace not being heated to the required temperature, the gases cool below their ignition point and escape unburned.

2. When so much coal is burned on the grate that it is impossible to supply sufficient air without frequent poking. This condition usually results in so large a volume of gas from the coal that it can not be properly mixed with air and burned in the combustion chamber. On reaching the boiler surfaces it is cooled, combustion is arrested, and soot and smoke result.

3. When the rate of combustion is suddenly increased, as when more coal is added, and fires are poked to get up pressure in short time.

4. When the fires are checked by closing doors or dampers, thus cutting off the air supply. Banked fires are difficult to maintain and start up without smoke. Automatic dampers are frequently the cause of smoke when not properly adjusted or designed.

There is need of further study of coals, furnaces, and combustion, but enough is now known to enable an engineer to design and operate a steam plant without objectionable smoke.

Fire-extinguishing Mixture.—Dissolve in 200 parts water 2 parts by weight of powdered alum, 2½ parts of powdered Glauber's salt, and 4 of soda-water glass (35 per cent). The fluid obtained can immediately be used for extinguishing fires.

ELECTRICAL NOTES.

Electricity excels all other methods of transmission for convenience. An electric cable may be strung where required, and machinery may be arranged in any position without reference to line shafting. There are instances, however, where rope drive will save both in first cost and in cost of operation, particularly when the process of manufacturing calls for a number of parallel shafts with machines nearly in one plane.

For some time past the Oerlikon firm have been carrying on a series of practical tests upon traction on the single-phase system, using for the purpose the section of standard gage railroad between Seebach and Wittingen. A number of interesting points have been brought out in the tests. A tension of 15,000 volts is used on the electric locomotives. During the first period of the trials a frequency of 50 cycles was employed; then this was reduced to 15 cycles. This was done from the fact that while the former current was usually produced in the central stations, it was found that the low frequency had an advantage for alternating-current motors with commutators, and especially for the series motors. To this end the company built a single-phase locomotive which was equipped with two motors of the series type having a capacity of 200 horse-power. A single trolley wire brought the current to the locomotive, with a rail return. A recently-patented trolley is used in this case. It is of the rod form, and the wire is run at the side of the track. In the experiments, the trolley wire is suspended in three different ways, using a fixed suspension, an elastic suspension by sliding rods working with springs, and also by means of carrying wires. As regards the rolling stock, it consisted in the first place of a locomotive which carried upon it a rotary converter so as to receive the alternating current and produce direct current for the motors, which were of the latter type. Later on, a locomotive was employed which used the single-phase current upon the motors by means of transformers. These two locomotives have four axles and double bogie. Each of the bogies carries a 200-horse-power motor, driving the wheels by gears and connecting bars. The single-phase locomotive is said to have given excellent results in the tests.

Recent researches have shown the surface of the earth as well as the neighboring air strata to be permanently charged with negative electricity, while the atmosphere in its upper strata possesses a positive charge increasing with the altitude. On the other hand, the atmosphere can no longer be considered a perfect insulator. Ionization causes a certain conductibility or rather a permanent condition between the surface of the earth and the higher strata. Hence any electrical charge of our globe would necessarily vanish unless it be continually renewed from some outside source. A French scientist, M. A. Nodon, has been engaged for about two years in studying this interesting subject. The results of his investigation are at variance with the opinions so far held, proving the existence of both local and temporary variations in the potential of the earth. A portable electrometer similar to the Curie instrument was used in these experiments, the terminals being surrounded by a sleeve of paraffined paper protecting the apparatus against external electric dispersion. The experimenter studied both slow, gradual variations and rapidly oscillating variations in the potential of the earth. On June 23, 1907, he noted at 7:30 P. M. (at moonrise) that the negative potential of the soil and the surrounding air decreased 150 volts within fifteen minutes. On August 14 of the same year the negative charge of the soil decreased in tension 200 volts between 3 and 3:20 P. M. The charge of the earth was found to remain constant during fine weather as well as during permanent rain, while any alteration in the atmospheric condition was manifested by considerable variations of the earth potential. Small oscillating alterations of 25 to 50 volts per minute would seem to be due to ordinary changes in the weather, while marked alterations (of 150 to 200 volts) are attributable to deeper disturbances, such as for instance thunderstorms, storms, cyclones. The heaviest disturbances (up to 300 to 400 volts per second) must be ascribed to earthquake phenomena, which in turn are due to similar causes. Nodon was therefore able to ascertain by this method the presence of several distant earthquakes, and the following is an especially interesting observation made by himself on December 15, 1907, at Bordeaux, France, and communicated to the Academy of Sciences. On that date the electrometer during the forenoon did not indicate any special disturbances, the weather being fair and nothing presaging the occurrence of atmospheric disturbances. However, the electrometer (located in a closed room) indicated at 1:15 P. M. the existence of heavy disturbances corresponding with alterations in potential as high as 350 volts per second, which after lasting for about half an hour, gradually decreased until at 2:20 P. M. these variations of potential were only 20 volts per minute, in order to disappear entirely by 6:30. Convinced of the approach of a heavy hurricane and of earthquake disturbances, Nodon immediately advised the foremost scientists, all of whom confirmed his prediction by stating the occurrence of earthquake disturbances and of a frightful hurricane raging throughout the whole of Europe.

SCIENCE NOTES.

The Fourth Congress of Mathematics, which was held at Rome from the 6th to the 11th of April, proved to be a great success, and it counts more than 600 members among the leading scientists of the different countries. It was held in the Capitol in the presence of King Victor Emmanuel, who wished to testify his interest in the congress. While in Rome, the members were shown great attention by the Minister of Public Instruction, the Syndic of Rome, the Rector of the University, and other leading officials. The Royal Academy of the Lincei placed at the disposition of the congress its rooms in the Corsini Palace, and the president of the Academy, Senator Blaserna, who was nominated president of the congress by acclamation, followed all the sessions and prevented any difficulties which might have arisen. One of the main advantages of the congress was in allowing scientists working in the same field to become acquainted and to discuss different questions. At the last session the English delegates expressed the desire to have the next congress held at Cambridge in 1912, and this was accordingly decided.

It is well known that olive trees will live to an extreme age, and trees are known which are many centuries old. What is known as Plato's olive tree is one of the oldest upon record. It stands near Athens and on the spot where the Academy formerly existed. In spite of its great age, it still appears to be in a flourishing condition and has a vigorous foliage. Although somewhat damaged by the combats of the insurrection, it will no doubt live for a long time to come. The proprietor of the ground, M. Vamvacas, had the tree examined by the naturalist Miliarakis in order to be assured whether the popular legend dating it from the time of Plato could be correct, and it was found that its age was sufficient to bear out the legend. As to the popular belief, M. Camburoglus, conservator of the National Library of Athens, states that tradition has it that the tree was no doubt already old when Plato sat under its shade. M. Vamvacas had the idea of honoring this contemporary of the great philosopher by sending its olives as a present to the different sovereigns or presidents, and among others, President Roosevelt, who addressed him a reply of thanks for the unique present.

An important invention which is of great interest to the textile industry has recently been patented by an Irish inventor. This relates to the bleaching of linen yarn in hank, a process which is already being widely adopted for both dry and wet spun yarns. In this process large quantities of one or more numbers up to twenty-two hundredweight are immersed, after boiling, in a large tank, and treated with the usual chemic sour soap and size, then washed and thoroughly dried without any handling whatever. The result of this system is that work which formerly occupied several weeks can now be accomplished in a few days, and without broken ends. The material winds easily and with better weight after bleaching, the color throughout being uniform and free from spots. Not only is the process a rapid and safe one, involving a great economy in labor, with a greatly reduced risk of damage, but it can be carried out without any stoppage of the works owing to frost. Under these circumstances the method should be extensively adopted, the experience in the Irish mills where it is in operation having emphasized its value.

Some of the most careful and painstaking work on the hydrolysis of proteins has been done in our own country by Dr. Thomas B. Osborne and his co-workers at New Haven. Examination of the results reported reveals several very important facts. Take, for example, some of the latest data afforded as in the hydrolysis of phaseolin, the globulin of the kidney bean, formerly called legumin. Here, sixteen different cleavage products were identified and determined. The method of hydrolysis and the methods of separating the different amino acids were carried out by persons skilled by long practice and under the best of conditions, yet the percentage of total cleavage products determined amounted to only 54.27. Again, in the hydrolysis of excelsin, the characteristic globulin of the Brazil nut, the total yield of cleavage products was 61.09 per cent. Finally, in the hydrolysis of hordein, the alcohol-soluble protein of barley, 71.32 per cent of cleavage products was separated. In other words, by the best methods available and in the hands of skilled workers trained to take advantage of all the knowledge available, chemists are able at present to separate and identify only 54 to 71 per cent of the total yield of cleavage products which results from the hydrolysis of protein. This undoubtedly means that there are still some building stones in the protein molecule with which as yet we are unfamiliar.

TRADE NOTES AND FORMULÆ.

To Clean Plaster Figures.—Apply a thick paste, prepared from good boiled starch, freely on the soiled figures with a soft brush, and leave the figures to dry in a draft. Only the dirt adheres to the paste, which comes off in thin layers, and the figures will appear like new. In case, however, they are not yet quite white, brush them with zinc varnish suspended in water.

Starch Laundry Glaze.—7½ parts by weight spermaceti, 2 parts gum arabic powder (limpid), 5½ parts rice starch, 2 4/5 parts powdered borax (prime). Moisten the spermaceti with alcohol; it can then easily be pulverized. Then add the powdered rice starch, and finally the powdered gum arabic; sift well, and mix thoroughly with the borax powder. Pack this preparation into paper bags with directions for use. Use one teaspoonful of the mixture to about 1/5 of a pound of starch.

Mustard Paper.—I. Cut ordinary thin writing paper into pieces 2½ inches by 4, moisten the pieces evenly with oil of mustard, and pack them either in paraffined paper or in tinfoil. They must be packed at once or the oil will be volatilized. A piece of this paper, laid on the skin and covered with a cloth, acts like a mustard plaster. II. Spread mustard, completely deprived of its oil by benzine in a suitable extraction apparatus, upon unsized paper in the following manner: Mix the mustard powder with a rubber solution made of 500 parts rubber, 100 parts rosin, 100 parts Damara varnish, 1500 parts benzine, and spread in a layer, not too thick, with the hand or by means of a suitable apparatus, on thick paper. Or apply the solution alone, sprinkle the mustard on it, and leave to dry.—Neueste Erfindungen und Erfahrungen.

Waxed Paper.—This is used for keeping substances which either contain volatile aromatic ingredients or grease, which would penetrate through ordinary paper. On a flat sheet of copper over a gentle fire place a sheet of paper as a base, and then lay a second sheet on the top of the first, coat this second sheet with yellow or white wax, and distribute the latter uniformly over the entire sheet by means of a sponge, exerting a little pressure, till the paper is everywhere transparent, and consequently permeated by the wax. If the fire is too feeble, the process will be retarded; too powerful a flame is still more harmful, as the paper is liable to become brown or black. Stearine may be used instead of wax.—Der Industriöse Geschäftsmann.

Practical Experiences in the Extermination of Rats.—Attention has been frequently called to the efficacy of the sea onion (squill) as a rat destroyer. In the Praktischer Ratgeber im Obst und Gartenbau Joh. Böttner gives the results of a trial of this article. Squills were crushed and ground in a machine together with a like quantity of potatoes and fried in a pan with some fat, the process being somewhat similar to that of baking potato tarts. These tarts were placed in the stables in the evening together with some vessels of water. Forty-three dead rats were the result. As it was not believed that there were so many rats, not enough tarts had been prepared, and a few of the animals remained alive. A second trial was made, chopped-up meat being mixed with the squills as a change, but the rats refused to touch them. After waiting about three months, sea onions were again crushed with potatoes and made into tarts with fat, but care was taken this time to prepare a sufficient quantity. The result was that 32 rats were killed. Since that time no rats have been seen in the place. One advantage of the squill or sea onion is that it is destructive only to rodents. Care must be taken while crushing that the juice does not come in contact with the hands, as it is liable to cause painful burning.

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